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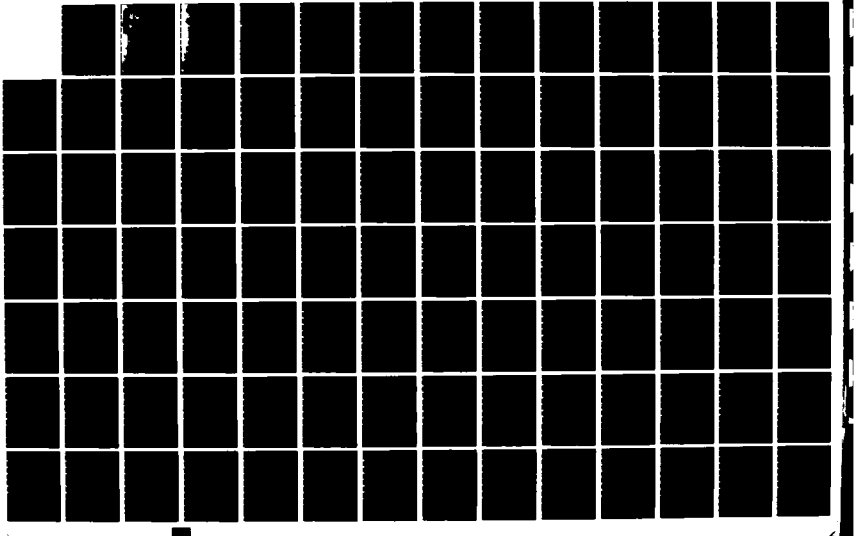

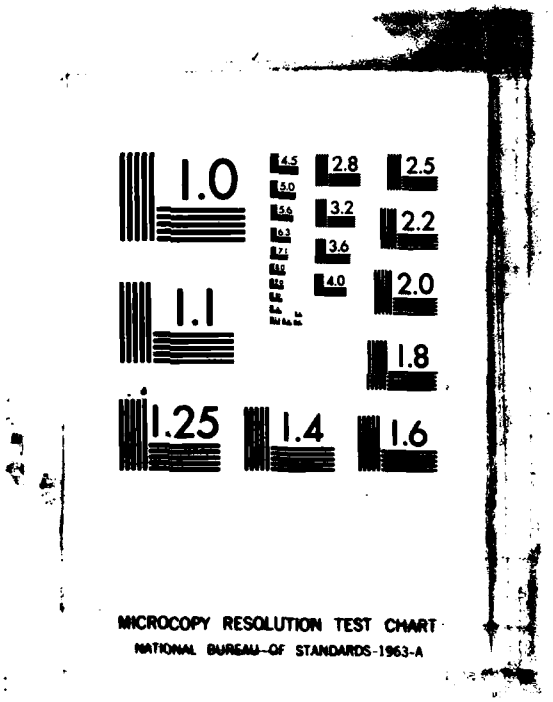
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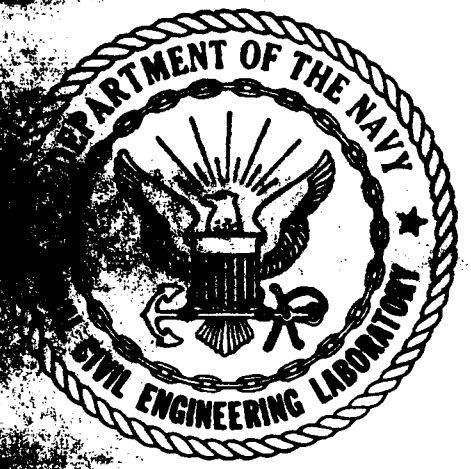

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COAL-USE ECONOMICS METHODOLOGY FOR NAVY BASES
VOLUME I OF ENGINEERING SERVICES FOR COAL CONVERSION GUIDANCE

February 1984

BECHTEL GROUP, INC.
P.O. Box 3965
San Francisco, CA 94119

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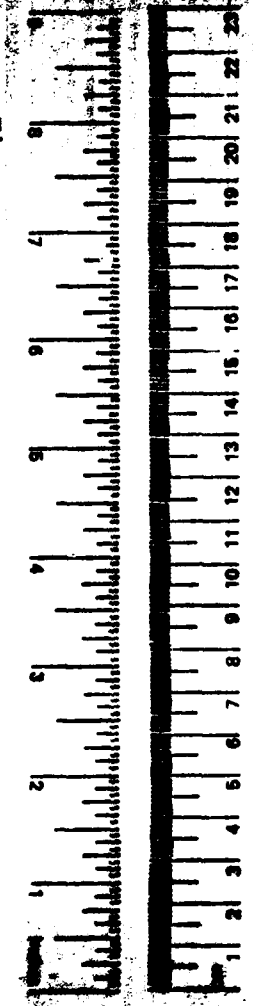
Approximate Conversions to Metric Measures

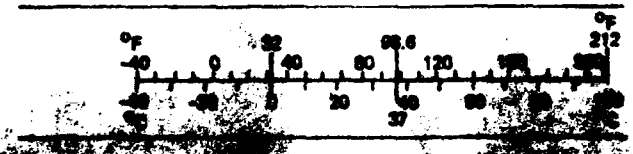
Symbol	When You Know	Multiply by	To Find	Symbol
		LENGTH		
in	inches	*2.5	centimeters	cm
ft	feet	30	centimeters	cm
yd	yards	0.9	meters	m
mi	miles	1.6	kilometers	km
		AREA		
in^2	square inches	6.5	square centimeters	cm^2
ft^2	square feet	0.09	square meters	m^2
yd^2	square yards	0.8	square meters	m^2
mi^2	square miles	2.6	square kilometers	km^2
	acres	0.4	hectares	ha
		MASS (weight)		
oz	ounces	28	grams	g
lb	pounds	0.45	kilograms	kg
	short tons (2,000 lb)	0.9	tonnes	t
		VOLUME		
tsp	teaspoons	5	milliliters	ml
Tbsp	tablespoons	15	milliliters	ml
fl oz	fluid ounces	30	milliliters	ml
c	cups	0.24	liters	l
pt	pints	0.47	liters	l
qt	quarts	0.95	liters	l
gal	gallons	3.8	liters	l
ft^3	cubic feet	0.03	cubic meters	m^3
yd^3	cubic yards	0.76	cubic meters	m^3
		TEMPERATURE (exact)		
°F	Fahrenheit temperature	5/9 (after subtracting 32)	Celsius temperature	°C

*1 in = 2.54 (exactly). For other exact conversions and more detailed tables, see NBS Misc. Publ. 286, Units of Weights and Measures, Price $2.25, SD Catalog No. C13.10:286.



Approximate Conversions from Metric Measures

Symbol	When You Know	Multiply by	To Find	Symbol
		LENGTH		
mm	millimeters	0.04	inches	in
cm	centimeters	0.4	inches	in
m	meters	3.3	feet	ft
m	meters	1.1	yards	yd
km	kilometers	0.6	miles	mi
		AREA		
cm^2	square centimeters	0.16	square inches	in^2
m^2	square meters	1.2	square yards	yd^2
km^2	square kilometers	0.4	square miles	mi^2
ha	hectares (10,000 m^2)	2.5	acres	
		MASS (weight)		
g	grams	0.035	ounces	oz
kg	kilograms	2.2	pounds	lb
t	tonnes (1,000 kg)	1.1	short tons	
		VOLUME		
ml	milliliters	0.03	fluid ounces	fl oz
l	liters	2.1	pints	pt
l	liters	1.06	quarts	qt
l	liters	0.26	gallons	gal
m^3	cubic meters	35	cubic feet	ft^3
m^3	cubic meters	1.3	cubic yards	yd^3
		TEMPERATURE (exact)		
°C	Celsius temperature	9/5 (then add 32)	Fahrenheit temperature	°F



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coal, economics, methodology, conversion

20 ABSTRACT (Continue on reverse side if necessary and identify by block number)

A methodology for calculating coal facility life cycle costs using commercial economic methods as well as Navy economic methods was prepared. The methodology permits calculation of life cycle present values, unit present values, levelized costs, and unit levelized costs for Navy financed/Navy operated ventures, third party financed/Navy

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operated ventures, and third party financed/third party operated (all private) ventures. The methodology also permits calculation of savings/investment ratios and payback periods for the three venture types.

The attached user manual was prepared for a computer program that calculates coal-use project life cycle costs under both Navy and commercial economic assumptions. The manual describes computational methods, program input, program output, program execution, error processing, test procedures, and code structure. Appendices include output generated for four sample cases and a procedure to converge to a desired calculated quantity by a method of successive trials.

NOTICE

This report was prepared by Bechtel Group, Inc. (BGI) as an element of work performed under, and in accordance with, the provisions of the U.S. Naval Civil Engineering Laboratory (NCEL) Contract N62474-82-C-8290. Neither BGI nor any person acting on its behalf makes any warranty, express or implied, with respect to the use of any information, apparatus, method, or process disclosed in this report, or that such use may not infringe privately owned rights; or assumes any liabilities with respect to the use of, or for damages resulting from the use of, any information, apparatus, method, or process disclosed in this report.

ACKNOWLEDGMENTS

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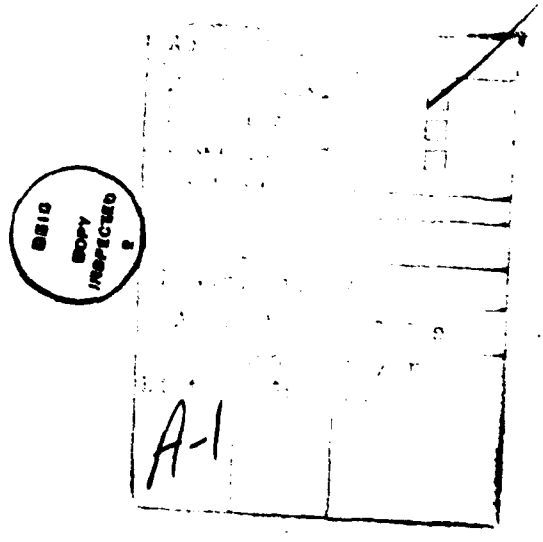
Computer program COALR has been adapted by Bechtel from COALC - Coal Conversion Cost Program, written by C. R. Biddle and R. I. Malakoff of Peter L. Loftus Corporation, Pittsburgh, Pennsylvania. C. R. Biddle provided helpful advice on features of the program.



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Section 1

INTRODUCTION

The Naval Civil Engineering Laboratory (NCEL) at Port Hueneme, California, is developing data and computational tools for calculating the cost of converting shore station heating and power generation facilities from high-priced oil and natural gas to lower-priced coal.

This report describes the work performed by Bechtel Group, Inc. to support these NCEL efforts, in Phase I of Navy Contract N62474-82-C-8290 with NCEL, entitled, "Engineering Services for Coal Conversion Guidance." This contract is a 15-month effort with three concurrent phases.

The Phase I work included definition of a methodology for calculating coal facility life cycle costs using commercial economic methods, as well as the economic methods customarily used by the Navy. It also included preparation of a computer program to permit converting from one of the forms of economic analysis into the other. Results of these analyses may be used by the Navy as economics input to decisions on shore station heating plant projects.

The Phase II work included development of a data base on the cost and performance of burning coal-water mixtures and coal-oil mixtures in coal-capable retrofitted boilers, and incorporation of this information in a computer program. This program calculates component and total costs of steam and power generation facilities for a Navy base of arbitrary configuration, under a variety of user-chosen assumptions. The program calculates life cycle costs under commercial as well as Navy economic assumptions. The program includes data prepared for NCEL on previous studies and the new data generated in the Phase II work.

The Phase III work included updating a previous study for NCEL, which compared a variety of coal conversion technologies under several degrees of steam plant decentralization, and preparation of a computer program to present the technology comparisons under a variety of user-chosen assumptions. The program includes the capability of calculating life cycle costs using Navy or commercial economics. The Phase III data includes costs for converting coal to gaseous and liquid fuels developed in prior studies for NCEL.

The computer programs for the three phases were adapted from a computer program prepared previously for NCEL. There is a separate report for each phase of the contract, and a separate user's manual for the computer program developed in each phase.

1.1 OBJECTIVES

The objectives of the Phase I effort were to:

- Formulate a coal-use economics methodology that calculates financial statistics using both Navy and commercial financial assumptions
- Prepare the Phase I computer program to automate the coal-use economics methodology

1.2 TECHNICAL APPROACH

Formulation of the coal-use economics methodology included the following steps:

- Establishment of methodology requirements
- Selection of analysis methods
- Structuring of the calculation procedures
- Preparation of calculation algorithms

The methodology is to have the following capabilities:

- Calculation of life cycle costs in both startup year dollars and dollars of some other "display" year

- Calculation of cost savings when oil or gas, burned in existing boilers, is replaced with coal
- Calculation of costs using both Navy and commercial financial assumptions in the same runs so results can be compared
- Accommodation of the following economic scenarios:
  - Navy financed and operated
  - third-party financed and Navy operated
  - privately financed and operated
  - nonprofit entity financed and operated
- Inclusion of general inflation and differential inflation for purchased energy, such as electricity, coal, natural gas, fuel oil, and steam
- Provision to use various capital structures, depreciation rates, and tax rates

After establishment of the above requirements, the following analysis methods were selected:

- Present value analyses were made the basis for all calculations.
- Inflation factors were introduced, and the relationship between current (inflating) dollars and constant (real) dollars was defined.
- Life cycle costs were converted to Navy levelized costs and commercial minimum revenue requirements.
- Comparisons with a base case of oil or gas consumption were calculated on a year-by-year basis by discounting Navy savings and commercial after-tax cash flows.

The calculation procedures were then structured into logically discrete routines, and calculation algorithms for all routines were prepared.

Following formulation of the methodology, the Phase I computer program was prepared. The program structure was adapted from the already existing NCEL computer program in the following manner:

- Input interpretation routines were retained and user input recognition and echo routines were prepared.
- A routine was built to reformulate input project costs to allow the user to select the desired year and cost basis.
- The existing program's Navy economics routine was updated and two additional Navy economics routines were prepared.
- Routines were added to calculate investor cash flows during construction and operating periods and to calculate commercial minimum revenue requirements.
- Summary routines were prepared.

Upon completion, program results were verified by comparison with hand calculations for the various program options.

The Phase I work used a number of Navy documents as references: References 1-1 through 1-4 describe the Navy economics methodology incorporated in the coal-use economics methodology. Reference 1-5 gives Navy recommended differential inflation rates used in this report to generate the technology cost comparisons. Reference 1-6 describes the existing NCEL computer program which was used in the construction of the Phase I computer program.

1.3 REPORT ORGANIZATION

Section 2 summarizes the results of the Phase I efforts resulting in the coal-use economics methodology and its embodiment in the Phase I computer program. Section 3 presents the coal-use economics methodology. Section 4 describes automation of the methodology in the Phase I computer program. It describes the reports generated by the methodology for Navy, third party/Navy, and all private ventures, and the summary reports comparing Navy and commercial economic scenarios. Section 5 describes use of the methodology for projects undertaken by nonprofit and governmental entities.

Section 2

SUMMARY

This section summarizes the results of the Phase I efforts to develop a coal-use economics methodology and its embodiment in the Phase I computer program.

2.1 THE COAL-USE ECONOMICS METHODOLOGY

The coal-use economics methodology has been constructed as a versatile tool to display side by side the results of economic analyses with different economic scenarios. The methodology has the following capabilities:

- Economic analyses using both Navy and commercial financial assumptions
- Determination of seven commonly recognized financial statistics
- Treatment of three venture structures
- Statistics in both startup year and display year dollars
- Economic comparisons of coal use with the use of fuel oil or natural gas

2.1.1 Navy and Commercial Economics

The methodology includes both Navy and commercial economic analyses. Similarities between the two analyses are that:

- Both are based upon computation of project present values, using discount rates chosen by the user.
- Both aim to produce capital charge rates typical of those encountered in the private sector.

The two analyses differ principally in the way they take into account corporate income taxes paid by the private sector:

- The Navy economic analysis achieves the reality of private sector capital charges by using a discount rate that is an average of corporate gross profit rates since World War II. This discount rate includes both the cost of return to investors and an allowance for the cost of private sector corporate income taxes. Since the Navy pays no income taxes, they are not explicitly calculated.

- The commercial economic analysis uses a discount rate that contains only return to investors. This discount rate produces a capital charge term that contains only return to investors. To obtain a total capital charge, a term is added for capitalizing the corporate income taxes, calculated under present or previous tax laws for depreciation and investment credits.

2.1.2 Financial Statistics

The coal-use economics methodology operates on project costs (capital and operating costs) to produce seven commonly recognized financial statistics for comparing energy project life cycle costs. These statistics are:

- Present value
- Unit present value
- Levelized cost
- Unit levelized cost
- Savings/investment ratio
- Discounted payback period
- Simple payback period

All seven statistics are calculated for commercial economics. Only the first six are calculated for Navy economics. For both Navy and commercial economics, the levelized costs and unit levelized costs are calculated in constant (real) dollars. Unit levelized costs in constant dollars per million Btu can be validly compared with current purchased energy prices.

2.1.3 Venture Structures

The methodology treats the following three venture structures:

- Structure 1 - Navy financing/Navy operation
- Structure 2 - Third party financing/Navy operation
- Structure 3 - Third party financing/third party operation (all private)

Statistics for Structure 1 are calculated with Navy economics only. Statistics for Structure 2 are calculated using Navy economics, except for lease payments, which are determined by commercial economics. Statistics for Structure 3 are calculated entirely with commercial economics. Structure 3 can also be used for nonprofit organizationeprojects by ignoring taxes.

2.1.4 Startup Year Versus Display Year Dollars

The financial statistics are presented in both plant startup year dollars and dollars of an arbitrary year selected by the user, called the display year. Purchased energy price input data are entered in display year dollars.

2.1.5 Comparisons with Use of Oil or Gas

The methodology includes analyses of both the costs and economic benefits of displacing fuel oil or natural gas by a new coal-use project. The comparison analyses calculate three financial statistics: the savings/investment ratio, the discounted payback period, and the simple payback period.

2.2 THE PHASE I COMPUTER PROGRAM

The Phase 1 computer program, entitled "COALR - Coal Conversion Cost Reformulation Program," includes the entire coal-use economics methodology described above. The program operates on project costs, which are input by the user, and the output is reformulated to the user's choice of display year and cost basis.

Figure 2-1 names the 14 possible reports generated by the Phase I program. The Navy financed/Navy operated venture option is reported for all runs. The other reports generated in a given run depend on the user-selected commercial venture option (third party financed or all private).

Table 2-1 compares Navy and commercial financial statistics from a typical run of the Phase I computer program. The results show that the Navy and commercial analyses produce levelized costs of comparable magnitude.

In summary, the coal-use economics methodology and the computer program COALR constitute a versatile analytical tool for comparing the economic viability of options to supply steam at Navy shore bases. The program also served as a basis for the programs in Phases II and III of this contract.

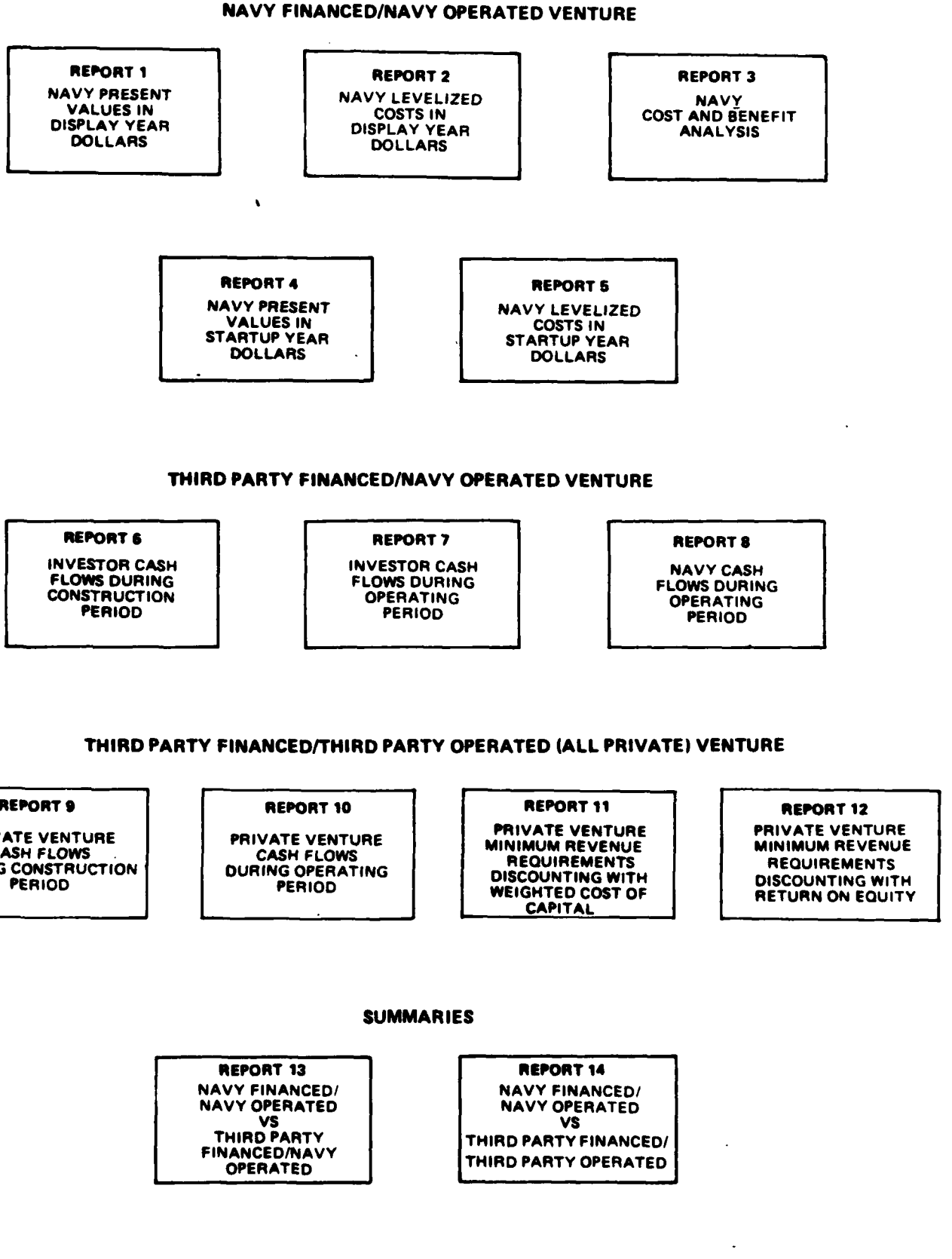


Figure 2-1 COAL-USE ECONOMICS METHODOLOGY REPORTS

Table 2-1

COMPARISON OF FINANCIAL STATISTICS
USING NAVY AND COMMERCIAL ECONOMICS
FOR A TYPICAL COAL-USE PROJECT(1)

Statistics (in 1982 display year dollars)	Units	Navy Financed/ Navy Operated Venture(2)	Privately Financed/ Privately Operated Venture(3)
Present Value of Life Cycle Costs	$10^3$$	68,121	87,114
Unit Present Value of Life Cycle Costs	$/10^6$ Btu	3.11	3.97
Levelized Cost (constant dollar)	$10^3$$/yr	11,518	12,024
Unit Levelized Cost	$/10^6$ Btu	13.13	13.70
Savings/Investment Ratio	dimensionless	6.2	6.1
Discounted Payback Period	years	4.1	4.0
Unit Levelized Cost Details ($ per 10^6 Btu of steam)			
Return Required by Investors		N/A	2.67
Corporate Income Tax		N/A	0.50
Property Tax and Insurance		N/A	0.33
Total Capital Charge		3.13(4)	3.50
Operating Labor		1.94	1.94
Operating Material		1.33	1.33
Coal(5)		6.24	6.48
Purchased Auxiliary Energy			
Electricity(5)		0.67	0.70
Fuel Oil(5)		0.08	0.09
Natural Gas(5)		0.09	0.10
Steam(5)		0.05	0.05
Total Operating Cost		10.40	10.69
Total Levelized Cost		13.53	14.19

(1) The project is installation of a new 200,000 lb/hr stoker boiler central steam plant with a 1987 startup year and operation for 25 years at 50 percent load factor. Costs in 1982 display year dollars are as follows:

Construction	$21,722,000
Startup	$ 2,383,000
Annual Coal	$ 2,761,000
Other Annual Operating and Maintenance Costs	$ 3,179,000

(2) Present values are calculated with Navy economics using a constant dollar discount rate of 10 percent per year.

(3) Present values are calculated with commercial economics using a current dollar discount rate (weighted cost of capital) of 15.9 percent per year in the presence of 6 percent per year general inflation.

(4) The Navy analysis leads directly to a capital charge, and does not calculate return and taxes separately.

(5) Annual differential inflation rates for purchased energy are as follows (Reference 1-5):

Coal	5 percent/year
Electricity	6 percent/year
Natural Gas	10 percent/year
Fuel Oil	8 percent/year
Steam	6 percent/year

Section 3

THE COAL-USE ECONOMICS METHODOLOGY

The coal-use economics methodology was developed to assess the economic merits of projects to replace oil or gas with coal as steam generator fuel at Navy shore bases. As shown in Figure 3-1, the methodology uses cost estimates as input to produce financial statistics and reports as output.

In this section, the economic analysis methods and assumptions of the methodology are described in a way that highlights similarities between Navy and commercial financial analyses. The following subjects are discussed:

- Input data reformulation, dealing with adjustment of the cost estimate reference time
- Treatment of discounting and inflation, dealing with present values, levelized costs, general inflation, and differential escalation
- Life cycle cost analyses, dealing with closed form annuity calculations, producing the following coal-use project financial statistics:
  - Total present value
  - Unit present value
  - Levelized costs
  - Unit levelized costs
- Private sector income taxes
- Analyses of costs and benefits, dealing with year-by-year calculations to produce the following financial statistics:
  - Savings/investment ratio
  - Discounted payback period
  - Simple payback period

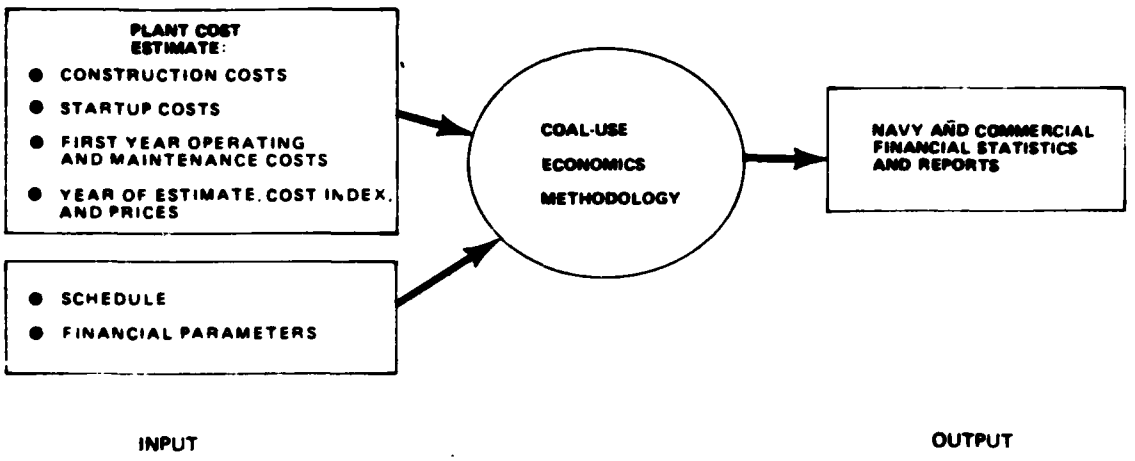


Figure 3-1 OPERATION OF THE COAL-USE ECONOMICS METHODOLOGY

- Ventures analyzed and reports generated, dealing with venture structures with combination of Navy and private interest participation in the financing and operation of the project

3.1 INPUT DATA REFORMULATION

3.1.1 Reference Times

The coal-use economics methodology works with the following three reference times:

- Base year - the year of the plant cost estimate
- Display year - a year chosen by the user for presentation of financial statistics
- Startup year - the year of plant startup

The user must specify the base year by providing the following cost parameters: plant cost index, hourly labor rate for operation and maintenance, and prices for purchased coal, electricity, fuel oil, natural gas, and auxiliary steam. These cost parameters are input by the user along with the cost estimate for plant installation and operation.

The display year and the startup year are selected by the user and are used as reference times for present value calculations in the financial analyses. To specify the selected display year, the user must input the

following cost parameters: plant cost index, hourly labor rate for operating and maintenance, and prices for purchased coal, electricity, fuel oil, natural gas, and auxiliary steam.

The user is free to select a preferred plant cost index system, but once selected, the same system must be used in a given analysis.

3.1.2 Adjustment of Cost Estimate Reference Times

The first step in the coal-use economics methodology is the conversion of the input cost estimate from base year dollars to display year dollars. This conversion (or reformulation) is performed in the following way:

- A ratio is formed for each cost parameter between the display year value (in the numerator) and the base year value (in the denominator).
- Construction, startup, and first year operating and maintenance material costs in the cost estimate are multiplied by the ratio of the plant cost indices for the display year (in the numerator) and the base year (in the denominator).
- Similarly, the first year purchased energy costs in the cost estimate are multiplied by the corresponding ratio of energy prices.

3.2 TREATMENT OF DISCOUNTING AND INFLATION

Once the cost estimate is available in display year dollars, the methodology then distributes the capital and first year costs to their year of occurrence in plant construction and operation, and then discounts the costs to their present values at a "Year 0" reference time (the display year or startup year, depending on the section of the code). In performing the calculations, the methodology makes frequent conversions between startup year and display year costs. In all of the calculations, user specified rates of inflation and differential inflation are taken into account.

3.2.1 Present Values

The coal-use economics methodology includes calculation of present values with a Navy discount rate and two different private sector discount rates, all of which can be set by user input:

- Navy discount rate - an opportunity cost which includes the equivalent of the return required by investors and an allowance for the capital charge associated with corporate income taxes.
- Return on equity - the return which private sector equity holders require on the equity portion of a private sector investment.
- Weighted cost of capital - the weighted average of private sector interest on debt and return required by equity holders. The weighted cost of capital is calculated from inputs of debt fraction, interest, and return on equity.

The present value of a construction period cash flow is the product of the amount of the cash flow and the discount factor for the year in which the cash flow occurs. According to the type of structure, the following conventions are used in the methodology for timing a cash flow for a given year:

- Navy convention - the cash flow is distributed uniformly over the year
- Commercial convention - the cash flow is assumed to occur at the end of the year

The discount factor formulas for cash flow used by the methodology are different in the two timing conventions.

The coal-use economics methodology includes closed form calculations of the present value of a stream of equal cash flows recurring annually for N years, known as annuity. The total present value of an annuity is calculated as the product of the first year cash flow and a "cumulative uniform series" discount factor.

3.2.2 Levelized Costs

The present value statistic is also converted by the coal-use economics methodology into a financially equivalent annuity known as levelized cost. Unit levelized costs (in dollars per million Btu of energy) are convenient because they can be validly compared with current prices for purchased energy in a noninflationary period. Navy levelized costs are discussed in Reference 1-2. Private sector levelized costs, also known as minimum revenue requirements, are discussed in References 3-1 and 3-2.

The levelized cost is the best statistic for comparing Navy and commercial economic analyses, because in levelized costs the effects of differing discount rates are minimized.

3.2.3 Effects of General Inflation

In the coal-use economics methodology, a user-specified general inflation rate is assumed to remain constant throughout the life of a project to install and operate a plant.

To separate cost effects resulting from inflation from those which are independent of inflation, the coal-use economics methodology distinguishes between costs in "current dollars" and those in "constant dollars":

- Current (inflating) dollar costs reflect changes which are to be paid at the time the costs are incurred. During inflationary periods, the prices of most commodities rise over time, so annually recurring costs will rise at or near the general inflation rate when expressed in current dollars.

- Constant (real) dollar costs reflect amounts that would be paid if the general prices and wage levels of a specific "Year 0" remained constant over time, as if general inflation were "turned off" at Year 0.

The coal-use economics methodology relates the discount rate in current dollars to the discount rate in constant dollars according to the relation:

$$(1 + r_{cur}) = (1 + r_{const})\ (1 + g)$$

where:

r_{cur} = current dollar discount rate

r_{const} = constant dollar discount rate

g = rate of general inflation

Table 3-1 compares typical current dollar and constant dollar discount rates for the three types of discount rate when there is a 6 percent per year general inflation.

Table 3-1

TYPICAL CURRENT DOLLAR AND CONSTANT DOLLAR DISCOUNT RATES FOR 6 PERCENT PER YEAR GENERAL INFLATION

Type of Discount Rate	Current Dollar Discount Rate, percent/year	Constant Dollar Discount Rate, percent/year
Return on Equity	18.00	11.1
Weighted Cost of Capital	15.90(1)	9.3
Navy	16.60	10.0

(1) The 15.90 percent per year value represents a project capital structure containing 70 percent equity paying 18 percent per year and 30 percent debt paying 11 percent per year.

Present values at a Year 0 are calculated by either of the following methods when inflation is present:

- Costs in current dollars are discounted at the current dollar discount rate.
- Costs in constant dollars referenced to Year 0 are discounted at the constant dollar discount rate.

The present values calculated by the two methods are identical and the coal-use economics methodology uses the two methods interchangeably.

Consistent with Navy convention, levelized costs are calculated in constant dollars in the coal-use economics methodology. Also, constant dollar levelized costs are convenient because they can be readily compared with Year 0 purchased energy prices.

Startup year present values are converted to display year present values in the methodology by discounting at the current dollar discount rate. Startup year levelized costs are converted to display year levelized costs by de-escalating at the general inflation rate.

3.2.4 Differential Inflation of Purchased Energy

To accommodate purchased energy prices which may increase faster than general inflation, the coal-use economics methodology allows specification of a separate differential inflation rate (DIR) for each purchased energy commodity. The DIR is approximately the amount by which the commodity inflation rate exceeds the general inflation rate, and it is defined exactly by the relation,

$$DIR = \frac{1 + e}{1 + g} - 1$$

Here,

e = energy commodity inflation rate, percent per year

g = general inflation rate, percent per year

Typical DIR values for various purchased energy commodities are given in Table 3-2. The methodology combines the DIR with the constant dollar discount rate "r" to obtain an effective discount rate "x" through the formula,

$$x = \frac{1 + r}{1 + DIR} - 1$$

This formula, the basis for tabulated discount factors in Reference 1-1, is used in both Navy and commercial life cycle cost analyses.

Table 3-2

TYPICAL DIFFERENTIAL INFLATION RATES
FOR ENERGY PURCHASED BY NAVY BASES

Type of Purchased Energy	Differential Inflation Rate (DIR)[1], percent/year
Coal	5
Electricity	6
Steam	6
Fuel Oil	8
Natural Gas	10

(1) The DIR values shown are those recommended in Reference 1-5.

3.3 PROJECT LIFE CYCLE COSTS

The coal-use economics methodology calculates the following four economic statistics from the costs of plant construction and operation:

- Present value
- Unit present value
- Levelized cost
- Unit levelized cost

These calculations consider only costs, and do not consider cash flows of income for sale of the products of the plant. The resulting financial statistics are called life cycle costs. In the private sector analysis they measure the minimum revenues the plant must earn through sale of products to pay all expenses and taxes and to pay investors the minimum return that they require. The Navy analysis leads to comparable life cycle costs.

Figure 3-2 is the cost cash flow diagram for a typical coal-use project for calculations with Year 0 as the startup year.

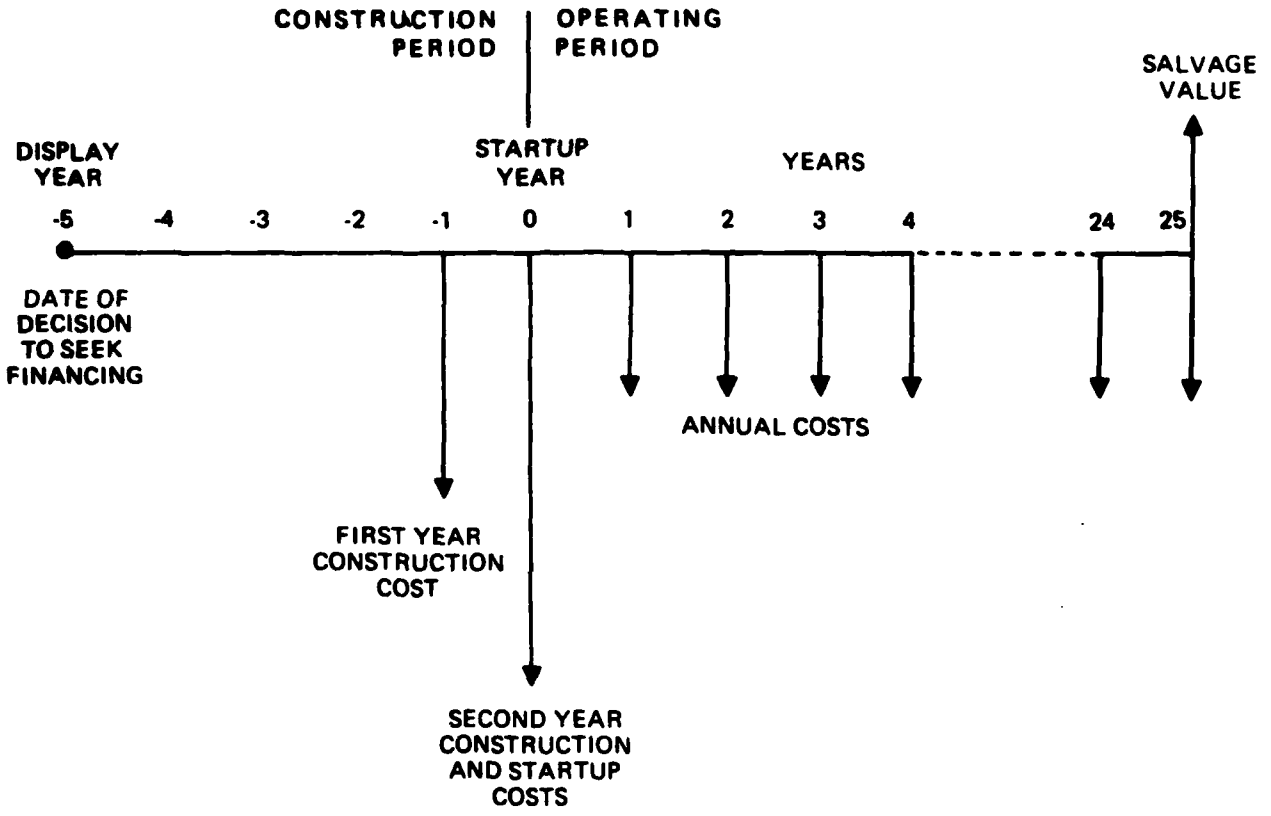


Figure 3-2 TYPICAL COST CASH FLOW DIAGRAM OF COAL CONVERSION PROJECTS

Construction period costs include the year-by-year construction costs and the startup (or owner's) costs incurred the last construction year. In commercial economic analyses, construction period costs are reduced by an investment tax credit. The present value of all construction period cash flows in startup year dollars is the total capital investment for the project.

Operating period costs, treated separately by the methodology, include the following cost items:

- Operating and maintenance labor
- Operating and maintenance materials
- Coal
- Auxiliary electricity
- Auxiliary oil
- Auxiliary natural gas
- Auxiliary steam

The present values of the operating period costs are calculated and summed to yield a total present value for operating and maintenance. The methodology assumes that the plant will operate at the same load factor each year of its specified economic life.

If there is salvage value at the end of the operating period, its present value is a negative entry in computing the total present value of project costs.

Levelized life cycle costs are calculated from the construction period present values and the operating period present values. The resulting costs associated with the investment appear as annual capital charges added to the levelized annual operating and maintenance costs.

The capital charge has similar magnitude in Navy and commercial economics, but it is calculated differently in the two analyses:

- In Navy economics, the capital charge is simply the levelized cost of the present value of the investment.
- In commercial economics, the capital charge is the sum of the following operating period levelized costs:
  - Return to equity holder
  - Debt service
  - Corporate income taxes
  - Property taxes and insurance

The methodology includes property taxes and insurance for privately operated ventures but not for Navy operated ventures, since local taxes are not levied on government land, and insurance is not usually included in Navy economic analyses. The annual property tax and insurance are typically 2 percent of the total capital requirement.

3.4 PRIVATE SECTOR INCOME TAXES

When calculating commercial minimum revenue requirements, the coal-use economics methodology calculates federal and state corporate income taxes as a function of the minimum revenue requirement for return to investors (the "after-tax cash flow") by the following tax formula:

$$T = \frac{t}{1 - t} \quad (A - D - I)$$

where

T = annual corporte income tax

t = the tax rate, typically 50 percent

A = annual after-tax cash flow

D = annual capital depreciation for tax purposes

I = annual interest paid on debt

Since capital depreciation and interest payments vary from year to year, the methodology performs a year-by-year calculation to determine the

corresponding tax and its present value. The total life cycle present value of income tax is obtained by summation.

The capital depreciation for tax purposes is calculated in the coal-use economics methodology by one of the following two methods, specified by the user (and summarized in Table 3-3):

- Sum-of-the-Years-Digits (SOYD), in use for several decades
- Accelerated Cost Recovery System (ACRS), introduced recently

The methodology calculates interest on debt on a year-by-year basis assuming constant annual payments for debt service (the sum of interest and principal).

The methodology permits the user to specify a percentage for an investment credit to reduce income tax during the construction period. This credit is subtracted from the total capital requirement to obtain the actual cost to investors.

3.5 ANALYSES OF COSTS AND BENEFITS

In addition to calculating the life cycle costs of a coal-use project, the methodology compares the coal-use project with burning oil or gas in existing boilers in a year-by-year analysis of costs and benefits. The analyses of costs and benefits are carried out to calculate comparison financial statistics, which are the savings/investment ratio and payback periods.

3.5.1 Navy Comparison Statistics

In the Navy analysis, the operating costs that would be paid for the oil- or gas-burning unit are calculated as benefits to the coal-use project, since the coal-use project. The benefits occur during the operating period when oil or gas is displaced by the coal-use project. The

Table 3-3

METHODS FOR CALCULATING CAPITAL DEPRECIATION FOR TAX PURPOSES

Item	Method 1 - Sum of the Years Digits	Method 2 - Accelerated Capital Recovery System
Definition of Tax Depreciable Capital **Notation** TDC = Tax Depreciable Capital, dollars CC = Construction Cost, dollars IDC = Interest During Construction, dollars SC = Startup (Owner's) Costs, dollars(1) ITC = Investment Tax Credit, dollars(2)	TDC = CC + IDC + 0.4 SC	TDC = CC + IDC + 0.4 SC - 0.5 ITC
Annual Depreciable Deduction **Notation** ADD = Annual Depreciation Deduction, dollars TDC = Tax Depreciable Capital, dollars DF = Depreciation Factor N = Depreciation Life, years n = Year of Payment	ADD = TDC · DF $DF = \frac{N - n + 1}{N(N+1)/2}$ for $n \leq N$ DF = 0 for $n > N$	ADD = TDC · DF Table of Depreciation Factors (DF) Year of Payment n N 1 2 3 4 .5 6 7 8 9 10 11 12 13 14 15 3 .25 .38 .37 0 0 0 0 0 0 0 0 0 0 0 5 .15 .22 .21 .21 .21 0 0 0 0 0 0 0 0 0 0 10 .08 .14 .12 .10 .10 .10 .09 .09 .09 .09 0 0 0 0 0 15 .05 .10 .09 .08 .07 .07 .06 .06 .06 .06 .06 .06 .06 .06 .06 DF is zero for all n greater than 15
Depreciation Life Selection	N may be any integer	Allowed values of N are 3, 5, 10, and 15 Methodology selects next lower allowed N if input N is between allowed N N = 3 applies to vehicles N = 5 applies to third party and most private ventures N = 10 and N = 15 apply to utilities and long-life private ventures

(1) Startup (Owner's) costs are assumed to include 40 percent depreciable capital and 60 percent nondepreciable capital.

(2) In the accelerated capital recovery system, half the investment tax credit must be subtracted in computing depreciable capital.

year-by-year annual savings caused by the coal-use project are then calculated as the difference between the annual benefits and the annual coal-use project operating and maintenance costs. The present values of the savings in each year are then calculated. The methodology finally calculates the savings/investment ratio and discounted payback period financial statistics in the following ways in the Navy analysis:

- The savings/investment ratio is the ratio of the total present value of savings to the total present value of the investment. If the savings/investment ratio exceeds 1.0, the coal-use project is financially attractive.

- The discounted payback period is the time until the cumulative present value of the savings becomes equal to the present value of the investment. If the discounted payback period is less than the operating life, the project is attractive.

3.5.2 Commercial Comparison Statistics

In the commercial economic analysis, the operating costs for burning oil or gas are considered as revenues for the coal-use project, under the assumption that the products of the coal-use project could be sold for the price of making them by burning oil or gas. The equivalent of "savings" in commercial economics is the after-tax cash flow.

The coal-use economics methodology makes calculations of both of the following commercial economic equivalents of savings:

- The after-tax cash flow (common in the regulated electric utility industry)

- The equity after-tax cash flow (common in unregulated industries, such as petroleum)

The after-tax cash flow is:

$$A = (1 - t)(R - E) + tD + tI$$

where

A = annual after-tax cash flow

t = the tax rate

R = total annual revenues

E = annual expenses

D = annual capital depreciation for tax purposes

I = annual interest paid on debt

In the after-tax cash flow analysis of the methodology, the present value of each annual after-tax cash flow is calculated year by year using the weighted cost of capital as the discount rate. Then the methodology calculates savings/investment ratio, discounted payback period, and simple payback period financial statistics:

- The savings/investment ratio is the ratio of the total present value of operating period after-tax cash flows to the present value of the investment. As before, the coal-use project is economically attractive if the savings/investment ratio is greater than 1.0.

- The discounted payback period is the time until the cumulative present value of the after-tax cash flows becomes equal to the present value of the investment.

- The simple payback period is the time until the cumulative after-tax cash flow becomes equal to the present value of the investment.

The equity after-tax cash flow analysis in the methodology differs from after-tax cash flow analysis in the following ways:

- The equity after-tax cash flow equals the after-tax cash flow minus debt service.

- Only the equity portion of the investment is used to compute the savings/investment ratio and payback periods.

- The discount rate is the return on equity.

3.6 VENTURES ANALYZED AND REPORTS GENERATED

The methodology was constructed to accommodate three different venture structures. These are:

- Navy financed/Navy operated venture
- Third party financed/Navy operated venture
- Third party financed/third party operated (all private) venture

For the all-Navy venture, results are presented in both display year dollars and startup year dollars to conform to two different conventions followed in the Navy. For the all-private venture, minimum revenue requirements are presented in display year dollars using both return on equity and the weighted cost of capital as discount rates to provide financial statistics appropriate for both regulated and unregulated industries.

Section 4

AUTOMATION OF THE COAL-USE ECONOMICS METHODOLOGY

The coal-use economics methodology, described in detail in Section 3, was automated by construction of the Phase I computer program, entitled "COALR - Coal Conversion Cost Reformulation Program." Adapted from the Reference 1-6 computer program, the COALR program has the following features:

- INFREE free-format input data interpretation, retained from the Reference 1-6 computer program
- Routines to recognize and store user input plant, utility, and Navy economic parameters
- A routine to recognize and store user input on coal-use costs to be reformulated, fuel to be displaced, and commercial economic parameters
- An interpretive input echo routine to assure storage of input in correct internal variables
- A routine to reformulate input coal-use costs to a display year dollar basis
- A routine calculating Navy present values and levelized costs, retained from the Reference 1-6 program
- Routines to perform cost and benefit analyses using Navy economics
- Routines to calculate third party and private venture financial statistics using commercial economics

Details of the COALR program are described in the user's manual, which is issued separately (Ref. 4-1). This section explains the reports produced by this program. As indicated in Figure 2-1, the program produces 14 cost reports. A group of five reports displays the financial statistics for Navy financed/Navy operated projects. A second group of three reports covers third party financed/Navy operated projects. The third group of four reports covers third party financed/third party operated (all private) projects. Finally, there are two summary reports providing

financial comparisons of the third party financed/Navy operated and the third party financed/third party operated (all private) projects with the Navy financed/Navy operated base case. The program always produces the statistics for the base case. The user selects one of the other scenarios for the run.

In subsequent portions of this section, the 14 cost reports are explained by samples produced for a stoker-fired central steam plant. The plant was assumed to have the following characteristics:

Plant capacity, lb/hr steam	200,000
Average load factor, %	50
Plant economic life, years	25
Startup year	1987
Display year	1982
Costs (fourth quarter 1982 dollars)	
- Construction	21,722,000
- Startup	2,383,000
- Annual coal supply	2,600,000
- Annual O&M costs	3,179,000

The reports were produced in two runs of the program: the first, specifying a third party financed/Navy operated commercial venture, and the second, specifying a third party financed/third party operated commercial venture. All other input information is identical for the two runs.

4.1 NAVY FINANCED/NAVY OPERATED VENTURES

This section describes the reports generated by the coal-use economics methodology for a typical venture that is Navy financed and Navy operated.

4.1.1 Report 1 - Navy Present Values in Display Year Dollars

Table 4-1 shows Report 1, which gives Navy present values in display year dollars. For the sample case, the display year was selected to occur 5 years before plant startup. Reading rows from the top, the report provides year-by-year costs during the construction and startup period.

Table 4-1

Report 1 -

NAVY PRESENT VALUES IN DISPLAY YEAR DOLLARS *

		COST (1000 $)	DISCOUNT FACTOR	PRESENT VALUE (1000 $)	UNIT PRESENT VALUE ** ($/MILLION BTU)
CONSTRUCTION	1986	8037.	.7166	5759.	.26
CONSTRUCTION	1987	13685.	.6515	8915.	.41
TOTAL CONSTRUCTION		21722.		14675.	.67
STARTUP	1987	2383.	.6515	1552.	.07
1987 - 2012					
LABOR		1703.	5.9135	10068.	.46
OPERATING + MAINTENANCE MATERIAL		1162.	5.9135	6874.	.31
ELECTRICITY		256.	13.5466	3472.	.16
GAS		19.	25.0000	487.	.02
STEAM		17.	13.5466	233.	.01
OIL		23.	18.2930	420.	.02
COAL		2762.	11.7108	32342.	1.48
TOTAL				70123.	3.20

* ALL COSTS AND PRESENT VALUES ARE REFERENCED TO THE DISPLAY DATE OF NOVEMBER 1982

** 21900. BILLION BTUS OF HEAT ARE TRANSFERRED IN 25.0 YEARS OF OPERATING LIFE

It then treats each distinct category of annual operating and maintenance cost as a separate annuity. Finally, it provides total costs.

The first column of the report contains costs in display year dollars. For construction and startup, the costs are the constant dollar equivalent of actual project cash flows. For the operating period, the costs are first year costs expressed in display year dollars.

The second column contains discount factors for the construction and operating periods. Construction period discount factors are for one-time cash flows. Operating period discount factors are cumulative uniform series discount factors that account for all years of plant operation. The discount factors are based on the constant dollar discount rate with adjustments for differential inflation.

The third column contains present values formed as the product of first column costs and second column discount factors.

The fourth column contains unit present values formed by dividing the third column present values by the number of Btu's of heat transferred (supplied to steam) over the project operating life.

4.1.2 Report 2 - Navy Levelized Costs in Display Year Dollars

Table 4-2 shows Report 2, which gives constant dollar Navy levelized annual costs in display year dollars. The row headings are identical to those in Table 4-1. The cost column is also identical to that in Table 4-1. The second column contains levelizing factors derived directly from the discount factors in Table 4-1. Each levelizing factor is the quotient formed by dividing the corresponding discount factor by the discount factor for operating material cost. The third column in Table 4-2 contains levelized costs formed as the product of first column costs and second column levelizing factors. The levelized cost is expressed in display year dollars. The fourth column contains unit levelized costs formed by dividing third column levelized costs by the number of Btu's of heat tranferred in one year of operation.

Table 4-2

Report 2 -

NAVY LEVELIZED COSTS IN DISPLAY YEAR DOLLARS *

		COST (1000 $)	LEVELIZING FACTOR	LEVELIZED COST (1000 $)	UNIT LEVELIZED COST ** $/MILLION BTU
CONSTRUCTION	1986	8037.	.1212	974.	1.11
CONSTRUCTION	1987	13685.	.1102	1508.	1.72
TOTAL CONSTRUCTION		21722.		2482.	2.83
STARTUP	1987	2383.	.1102	263.	.30
1987 - 2012					
LABOR		1703.	1.0000	1703.	1.94
OPERATING + MAINTENANCE MATERIAL		1162.	1.0000	1162.	1.33
ELECTRICITY		256.	2.2908	587.	.67
GAS		19.	4.2276	82.	.09
STEAM		17.	2.2908	39.	.04
OIL		23.	3.0935	71.	.08
COAL		2762.	1.9804	5469.	6.24
TOTAL				11858.	13.54

* ALL COSTS ARE REFERENCED TO THE DISPLAY DATE OF NOVEMBER 1982

** 876.00 MILLION BTUS OF HEAT ARE TRANSFERRED ANNUALLY

4.1.3 Report 3 - Navy Cost and Benefit Analysis

Table 4-3 shows Report 3 for a Navy economics cost and benefit analysis. The analysis involves a year-by-year calculation carried out with constant display year dollars. The first column indicates the year for the costs considered. The second and third columns repeat investment cash flow information from Reports 1 and 2.

The operating costs column contains the total operating and maintenance cost of the coal-use project for each year. Each entry is the sum of labor, material, and energy costs. The energy costs are differentially escalated before they are added to form the sum. The operating benefits column contains similar total operating and maintenance costs for the alternative oil-fired project. The savings column entries are the differences between the corresponding operating costs and operating benefits.

The present value discount factor column contains discount factors formed with the constant dollar discount rate. Present values for investment, operating costs, and savings are then given in the remaining three columns. The present values are formed by multiplying the discount factor times the corresponding cash flows. The year-by-year calculation of operating cost present values yields a total operating cost present value that is within 0.06 percent of the sum of operating period present values in Report 1. This small difference arises because the year-by-year analysis utilizes an approximation to the Report 1 uniformly distributed discount factor with differential inflation.

At the bottom of the report, the financial statistics derived from the analysis are presented. The present value, unit present value, levelized cost, and unit levelized cost for the coal-use project are presented. Then the savings/investment ratio and the discounted payback period derived from comparison with oil-firing are presented.

Table 4-3

Report 3 -

NAVY COST AND BENEFIT ANALYSIS
(THOUSANDS OF DISPLAY YEAR DOLLARS)

YEAR	CONSTRUCT COSTS	STARTUP COST	OPERATING COSTS	OPERATING BENEFITS	SAVINGS (OPERATING BENEFITS -COSTS)	PRESENT VALUE DISCOUNT FACTOR	PV* OF CONSTRUCT + STARTUP COSTS	PV OF OPERATING* COSTS	PV OF SAVINGS
1986	8037.					.717	5759.		
1987	13685.	2383.				.651	10468.		
1988			6921.	13163.	6242.	.592		4099.	3697.
1989			7130.	14150.	7020.	.538		3839.	3780.
1990			7351.	15216.	7866.	.489		3598.	3850.
1991			7582.	16368.	8785.	.445		3374.	3909.
1992			7826.	17610.	9784.	.405		3166.	3958.
1993			8083.	18953.	10870.	.368		2972.	3997.
1994			8353.	20402.	12049.	.334		2792.	4028.
1995			8637.	21967.	13329.	.304		2625.	4051.
1996			8937.	23656.	14720.	.276		2469.	4067.
1997			9252.	25481.	16229.	.251		2324.	4076.
1998			9583.	27451.	17868.	.228		2188.	4080.
1999			9933.	29578.	19646.	.208		2062.	4078.
2000			10300.	31875.	21575.	.189		1944.	4071.
2001			10687.	34356.	23668.	.172		1833.	4060.
2002			11095.	37034.	25939.	.156		1730.	4045.
2003			11524.	39926.	28402.	.142		1634.	4027.
2004			11977.	43050.	31073.	.129		1544.	4005.
2005			12453.	46422.	33969.	.117		1459.	3980.
2006			12955.	50063.	37109.	.107		1380.	3953.
2007			13483.	53996.	40512.	.097		1306.	3923.
2008			14040.	58242.	44202.	.088		1236.	3891.
2009			14627.	62827.	48200.	.080		1171.	3858.
2010			15246.	67779.	52533.	.073		1109.	3822.
2011			15897.	73125.	57228.	.066		1051.	3785.
2012			16584.	78899.	62315.	.060		997.	3747.
TOTAL	21722.	2383.	270457.	921590.	651133.		16227.	53903.	98739.

PRESENT VALUE OF COSTS = $ 70130. THOUSAND
UNIT PRESENT VALUE = $ 3.20 PER MILLION BTU (PV / 21900. BILLION BTU)
LEVELIZED COST = $ 11859. THOUSAND (PV * .1691)
UNIT LEVELIZED COST = $ 13.54 PER MILLION BTU (LEVELIZED COST / 876. BILLION BTU)
SAVINGS/INVESTMENT RATIO = 6.08 (PV SAVINGS / PV INVESTMENT)
DISCOUNTED PAYBACK PERIOD = 4.3 YEARS (NO. OF YEARS NEEDED FOR CUMULATIVE PV SAVINGS = PV INVESTMENT)

* PV DENOTES PRESENT VALUE

4.1.4 Reports 4 and 5 - Startup Year Dollar Tables

Table 4-4 shows Report 4, which contains Navy present values in startup year dollars. Table 4-5 shows Report 5, which contains Navy levelized costs in startup year dollars. Reports 4 and 5 are identical in form to Reports 1 and 2, respectively. To generate the startup year reports, investment and first year operating and maintenance costs are converted from current dollar display year costs to current dollar startup year costs, using general inflation and differential inflation escalation factors.

4.2 THIRD PARTY FINANCED/NAVY OPERATED VENTURES

This section describes the reports generated by the coal-use economics methodology for a typical venture that is third party financed and Navy operated.

4.2.1 Report 6 - Investor Cash Flows During Construction Period

Table 4-6 shows Report 6, which contains a year-by-year analysis of construction period financing by third party investors. The analysis is carried out in current dollars. Present values are calculated in startup year dollars.

The top table of the report establishes the investment present value at startup. Successive columns describe sources and uses of funds, tax savings and tax credits, the after-tax equity cash flow, and present values for total investment and the equity portion. The split between debt and equity is in accord with user input. Tax savings and credits during the construction period reduce the equity cash flow required during construction. The capital cost during the last construction year contains both the final year construction costs and the startup costs.

The bottom table of the report estabishes the tax basis for tax depreciation during the operating period. Successive columns show: the depreciable portion and total investment, interest on debt, a tax credit adjustment to the tax basis, and the resulting tax basis.

Table 4-4

Report 4 -

NAVY PRESENT VALUES IN STARTUP YEAR DOLLARS *

		COST (1000 $)	DISCOUNT FACTOR	PRESENT VALUE (1000 $)	UNIT PRESENT VALUE ** ($/MILLION BTU)
CONSTRUCTION	1986	10755.	1.1541	12413.	.57
CONSTRUCTION	1987	18313.	1.0492	19214.	.88
TOTAL CONSTRUCTION		29068.		31627.	1.44
STARTUP	1987	3189.	1.0492	3346.	.15
1987 - 2012					
LABOR		2278.	9.5237	21698.	.99
OPERATING + MAINTENANCE MATERIAL		1556.	9.5237	14814.	.68
ELECTRICITY		459.	16.3028	7484.	.34
GAS		42.	25.0000	1050.	.05
STEAM		31.	16.3028	501.	.02
OIL		45.	20.0507	906.	.04
COAL		4717.	14.7776	69704.	3.18
TOTAL				151131.	6.90

* ALL COSTS AND PRESENT VALUES ARE REFERENCED TO THE STARTUP DATE OF NOVEMBER 1987

** 21900. BILLION BTUS OF HEAT ARE TRANSFERRED IN 25.0 YEARS OF OPERATING LIFE

Table 4-5

Report 5

NAVY LEVELIZED COSTS IN STARTUP YEAR DOLLARS *

		COST (1000 $)	LEVELIZING FACTOR	LEVELIZED COST (1000 $)	UNIT LEVELIZED COST ** $/MILLION BTU
CONSTRUCTION	1986	10755.	.1212	1303.	1.49
CONSTRUCTION	1987	18313.	.1102	2018.	2.30
TOTAL CONSTRUCTION		29068.		3321.	3.79
STARTUP	1987	3189.	.1102	351.	.40
1987 - 2012					
LABOR		2278.	1.0000	2278.	2.60
OPERATING + MAINTENANCE MATERIAL		1556.	1.0000	1556.	1.78
ELECTRICITY		459.	1.7118	786.	.90
GAS		42.	2.6250	110.	.13
STEAM		31.	1.7118	53.	.06
OIL		45.	2.1054	95.	.11
COAL		4717.	1.5517	7319.	8.36
TOTAL				15869.	18.12

* ALL COSTS ARE REFERENCED TO THE STARTUP DATE OF NOVEMBER 1987

** 876.00 BILLION BTUS OF HEAT ARE TRANSFERRED ANNUALLY

Table 4-6

Report 6 -

THIRD PARTY FINANCED/NAVY OPERATED VENTURE:
INVESTOR CASH FLOWS DURING CONSTRUCTION PERIOD
(THOUSANDS OF DOLLARS)

	SOURCE OF FUNDS		USE OF FUNDS		TOTAL SOURCES AND USES	TAX SAVINGS FROM IDC DEDUCTION	TAX CREDITS	AFTER TAX EQUITY CASH FLOW	PRESENT VALUE	
YEAR	DEBT	EQUITY	CAPITAL COST	INTEREST ON DEBT					EQUITY** PORTION	TOTAL* INVESTMENT
1986	3044.	7103.	10147.	0.	10147.	0.	1015.	6088.	7184.	10563.
1987	6551.	15286.	21502.	335.	21837.	167.	1959.	13159.	13159.	19376.
TOTAL	9595.	22388.	31682.	335.	31983.	167.	2974.	19247.	20343.	29938.

* PRESENT VALUE AT STARTUP BASED ON RETURN ON EQUITY = 18.00 PERCENT PER YEAR

** PRESENT VALUE AT STARTUP BASED ON WEIGHTED COST OF CAPITAL = 15.90 PERCENT PER YEAR

CALCULATION OF TAX BASIS
(THOUSANDS OF DOLLARS)

	PLANT INVESTMENT (INCLUDING STARTUP)		INTEREST ON DEBT	TAX CREDIT ADJUSTMENT TO TAX BASIS	TAX BASIS
YEAR	DEPRECIABLE PORTION	TOTAL			
1986	10147.	10147.	0.	507.	9639.
1987	19589.	21502.	335.	979.	18944.
TOTAL	29735.	31648.	335.	1487.	28583.

4.2.2 Report 7 - Investor Cash Flows During Operating Period

Table 4-7 shows Report 7, which contains third party investor cash flows during the operating period. In this analysis, it is assumed that the third party investors receive uniform annual lease payments from the Navy over the 15-year life of the lease. (Note that the lease payments are uniform in current dollars; when expressed in constant dollars, they will decline over time.) At the end of the lease life, the facility becomes the property of the Navy. The lease payments must be sufficient to provide the required return to lenders and equity holders and to pay corporate income taxes. The lease payments therefore must be equal to the minimum revenue requirements shown in the second column. Subsequent columns provide the breakdown of the minimum revenue requirement and proof that the after-tax equity cash flow has a present value equal to the equity portion of the investments from Report 6.

The third and fourth columns contain the annual interest and debt service. The minimum revenue requirement minus the debt service equals the before-tax equity cash flow in the fifth column. The sixth column contains the depreciation computed for a ten year tax life by the ACRS method. The seventh column, taxable income, is the difference between the revenue requirement and the sum of interest plus depreciation. The corporate income taxes computed with a 50 percent tax rate are shown in the eighth column. The difference between the before-tax equity cash flow and the tax is the after-tax equity cash flow of the ninth column. The discount factor computed from the current dollar return on equity (ROE) is shown in the tenth column. The present value of the after-tax equity cash flow is given in the final column. By definition, the total present value agrees, within rounding, with the present value of the equity portion of the total investment of Report 6.

4.2.3 Report 8 - Navy Cash Flows During Operating Period

Table 4-8 shows Report 8, which contains Navy cash flows during the operating period. The report provides both a life cycle cost for the project and a cost and benefit comparison. The analyses are performed using Navy economics.

Table 4-7

Report 7-

THIRD PARTY FINANCED/NAVY OPERATED VENTURE:
INVESTOR CASH FLOWS DURING OPERATING PERIOD
(THOUSANDS OF DOLLARS)

YEAR	LEVELIZED MINIMUM REVENUE REQUIREMENT	DEBT SERVICE		BEFORE-TAX EQUITY CASH FLOW	DEPREC-IATION	TAXABLE INCOME	TAXES	AFTER-TAX EQUITY CASH FLOW	PRESENT VALUE (PV) AT STARTUP ROE = 18.00 PCT	
		INTEREST PORTION	TOTAL						FACTOR	AMOUNT
1988	6354.	1055.	1334.	5019.	4287.	1011.	505.	4514.	.847	3825.
1989	6354.	1025.	1334.	5019.	6288.	-960.	-480.	5499.	.718	3949.
1990	6354.	991.	1334.	5019.	6002.	-640.	-320.	5339.	.609	3250.
1991	6354.	953.	1334.	5019.	6002.	-602.	-301.	5320.	.516	2744.
1992	6354.	911.	1334.	5019.	6002.	-560.	-280.	5299.	.437	2316.
1993	6354.	864.	1334.	5019.	0.	5489.	2745.	2275.	.370	843.
1994	6354.	813.	1334.	5019.	0.	5541.	2770.	2249.	.314	706.
1995	6354.	755.	1334.	5019.	0.	5598.	2799.	2220.	.266	591.
1996	6354.	692.	1334.	5019.	0.	5662.	2831.	2188.	.225	493.
1997	6354.	621.	1334.	5019.	0.	5733.	2866.	2153.	.191	411.
1998	6354.	542.	1334.	5019.	0.	5811.	2906.	2114.	.162	342.
1999	6354.	455.	1334.	5019.	0.	5898.	2949.	2070.	.137	284.
2000	6354.	359.	1334.	5019.	0.	5995.	2997.	2022.	.116	235.
2001	6354.	251.	1334.	5019.	0.	6102.	3051.	1968.	.099	194.
2002	6354.	132.	1334.	5019.	0.	6221.	3111.	1909.	.084	159.
TOTAL	95303.	10420.	20015.	75288.	28583.	56300.	28150.	47138.		20343.

Table 4-8

Report 8 -

THIRD PARTY FINANCED/NAVY OPERATED VENTURE:
NAVY CASH FLOWS DURING OPERATING PERIOD
(THOUSANDS OF DOLLARS)

YEAR	LEASE COST CURRENT DOLLARS	LEASE COST CONSTANT DOLLARS	PV* FACTOR FOR LEASE	PV OF LEASE COST	OPERATING COSTS	OPERATING BENEFITS	SAVINGS (OPER. BENEFITS - COSTS)	PV FACTOR FOR SAVINGS AND OPERATING COSTS	PV OF OPERATING COSTS	PV OF SAVINGS
1988	6354.	4479.	.564	2528.	6921.	13163.	6242.	.592	4099.	3697.
1989	6354.	4225.	.513	2168.	7130.	14150.	7020.	.538	3839.	3780.
1990	6354.	3986.	.467	1860.	7351.	15216.	7866.	.489	3598.	3850.
1991	6354.	3761.	.424	1595.	7582.	16368.	8785.	.445	3374.	3909.
1992	6354.	3548.	.386	1368.	7826.	17610.	9784.	.405	3166.	3958.
1993	6354.	3347.	.350	1173.	8083.	18953.	10870.	.368	2972.	3997.
1994	6354.	3158.	.319	1006.	8353.	20402.	12049.	.334	2792.	4028.
1995	6354.	2979.	.290	863.	8637.	21967.	13329.	.304	2625.	4051.
1996	6354.	2810.	.263	740.	8937.	23656.	14720.	.276	2469.	4067.
1997	6354.	2651.	.239	635.	9252.	25481.	16229.	.251	2324.	4076.
1998	6354.	2501.	.218	544.	9583.	27451.	17868.	.228	2188.	4080.
1999	6354.	2359.	.198	467.	9933.	29578.	19646.	.208	2062.	4078.
2000	6354.	2226.	.180	400.	10300.	31875.	21575.	.189	1944.	4071.
2001	6354.	2100.	.164	343.	10687.	34356.	23668.	.172	1833.	4060.
2002	6354.	1981.	.149	294.	11095.	37034.	25939.	.156	1730.	4045.
2003	0.	0.	.135	0.	11524.	39926.	28402.	.142	1634.	4027.
2004	0.	0.	.123	0.	11977.	43050.	31073.	.129	1544.	4005.
2005	0.	0.	.112	0.	12453.	46422.	33969.	.117	1459.	3980.
2006	0.	0.	.102	0.	12955.	50063.	37109.	.107	1380.	3953.
2007	0.	0.	.092	0.	13483.	53996.	40512.	.097	1306.	3923.
2008	0.	0.	.084	0.	14040.	58242.	44202.	.088	1236.	3891.
2009	0.	0.	.076	0.	14627.	62827.	48200.	.080	1171.	3858.
2010	0.	0.	.069	0.	15246.	67779.	52533.	.073	1109.	3822.
2011	0.	0.	.063	0.	15897.	73125.	57228.	.066	1051.	3785.
2012	0.	0.	.057	0.	16584.	78899.	62315.	.060	997.	3747.
TOTAL	95303.	46111.		15985.	270457.	921590.	651133.		53903.	98739.

PRESENT VALUE OF COSTS	= $ 69888. THOUSAND		(LEASE PLUS OPERATING COSTS)
UNIT PRESENT VALUE	= $ 3.19 PER MILLION BTU		(PV / 21900. BILLION BTU)
LEVELIZED COST	= $ 11818. THOUSAND		(PV * .1691
UNIT LEVELIZED COST	= $ 13.49 PER MILLION BTU		(LEVELIZED COST / 876. BILLION BTU)
SAVINGS/INVESTMENT RATIO	= 6.18		(PV SAVINGS / PV LEASE)
DISCOUNTED PAYBACK PERIOD	= 4.2 YEARS		(NO. OF YEARS NEEDED FOR CUMULATIVE PV SAVINGS = TOTAL PV LEASE)

* PV DENOTES PRESENT VALUE.
** PRESENT VALUES ARE REFERENCED TO THE DISPLAY YEAR.
*** LEVELIZED COSTS ARE IN CONSTANT DISPLAY YEAR DOLLARS.

The top portion of the report contains cash flows and their present values. The first column contains the operating years. The project shown has a 25-year operating life. The second column contains the current dollar end-of-year lease payments from the Navy to the third party investors. Since the Navy economic analysis is carried out in constant dollars, the lease payments are first de-escalated to display year dollars, as shown in the third column. The fourth column provides constant dollar end-of-year discount factors. The fifth column provides the constant dollar present value of the lease payments obtained by multiplying the third column and the fourth column. The total present value of lease payments represents the total investment denominator in the savings/investment ratio.

The remaining columns in the upper part of the report are identical to columns in Report 3, the cost and benefit comparison for an all-Navy project. Successive columns contain operating costs, operating benefits, operating savings, the present value discount factor for savings and operating costs, and finally the present values of operating costs and savings.

The bottom of the report contains the financial statistics calculated from present values from the upper part of the report. The statistics are the same as those calculated in Report 3.

4.3 THIRD PARTY FINANCED/THIRD PARTY OPERATED (ALL PRIVATE) VENTURES

This section describes the reports generated by the coal-use economics methodology for a typical venture which is privately financed and privately operated. The venture involves capital and operating costs that are identical to those in the all-Navy venture described in Section 4.1.

4.3.1 Report 9 - Private Venture Cash Flows During Construction Period

Table 4-9 shows Report 9, which contains construction period cash flows for the private investors. Report 9 is identical to Report 6.

Table 4-9

Report 9 -

PRIVATE VENTURE CASH FLOWS DURING CONSTRUCTION PERIOD
(THOUSANDS OF DOLLARS)

YEAR	SOURCE OF FUNDS: DEBT	SOURCE OF FUNDS: EQUITY	USE OF FUNDS: CAPITAL COST	USE OF FUNDS: INTEREST ON DEBT	TOTAL SOURCES AND USES	TAX SAVINGS FROM IDC DEDUCTION	TAX CREDITS	AFTER TAX EQUITY CASH FLOW	PRESENT VALUE: EQUITY** PORTION	PRESENT VALUE: TOTAL* INVESTMENT
1986	3044.	7103.	10147.	0.	10147.	0.	1015.	6088.	7184.	10563.
1987	6551.	15286.	21502.	335.	21837.	167.	1959.	13159.	13159.	19376.
TOTAL	9595.	22388.	31648.	335.	31983.	167.	2974.	19247.	20343.	29938.

* PRESENT VALUE AT STARTUP BASED ON RETURN ON EQUITY = 18.00 PERCENT PER YEAR

** PRESENT VALUE AT STARTUP BASED ON WEIGHTED COST OF CAPITAL = 15.90 PERCENT PER YEAR

CALCULATION OF TAX BASIS
(THOUSANDS OF DOLLARS)

YEAR	PLANT INVESTMENT (INCLUDING STARTUP): DEPRECIABLE PORTION	PLANT INVESTMENT (INCLUDING STARTUP): TOTAL	INTEREST ON DEBT	TAX CREDIT ADJUSTMENT TO TAX BASIS	TAX BASIS
1986	10147.	10147.	0.	507.	9639.
1987	19589.	21502.	335.	979.	18944.
TOTAL	29735.	31648.	335.	1487.	28583.

4.3.2 Report 10 - Private Venture Cash Flows During Operating Period

Table 4-10 shows Report 10, which indicates operating period cash flows for the private operators. The top half of the report is a year-by-year current dollar cost and benefit analysis for a 25-year operating life. The first column contains the operating year. Asterisks indicate that information has not been printed for some years. The next seven columns contain current dollar amounts, and the final six columns contain present values at startup.

The second column contains operating expenses which are the current dollar expenses equivalent to the constant display year dollar costs for the operating period in Report 3. The third column contains operating benefits (revenues) on the same basis. The fourth column contains operating savings formed as the difference between the third and the second columns. The fifth column contains interest payments, calculated assuming a 25-year debt life. The sixth column contains tax depreciation, which is identical to the corresponding column of Report 5 for third party investors during the operating period.

The seventh column contains the after-tax net cash flow calculated from the savings, interest, and depreciation, using Equation (3-3). The eighth column contains the after-tax equity cash flow, formed by subtracting debt service from the after-tax net cash flow.

The ninth, tenth, and eleventh columns give present values calculated using the current dollar weighted cost of capital as the discount rate. The ninth column is the present value of expenses. The tenth column is the present value of interest plus depreciation, needed for calculating the present values of taxes. The eleventh column is the present value of the after-tax net cash flow.

The twelfth, thirteenth, and fourteenth columns give present values calculated using the current dollar return on equity. The twelfth column contains the present value of expenses plus debt service. The thirteenth

Table 4-10

Report 10-

PRIVATE VENTURE CASH FLOWS DURING OPERATING PERIOD
(THOUSANDS OF DOLLARS)

	CURRENT DOLLARS							PRESENT VALUE USING WEIGHTED COST OF CAPITAL *			PRESENT VALUE USING RETURN ON EQUITY **		
YEAR	OPERATING EXPENSES	OPERATING BENEFITS	OPERATING SAVINGS	INTEREST	TAX DEPRECIATION	AFTER-TAX NET CASH FLOW	AFTER-TAX EQUITY CASH FLOW	EXPENSES	INTEREST + TAX DEPRECIATION	AFTER-TAX NET CASH FLOW	EXPENSES + DEBT SERVICE	INTEREST + TAX DEPRECIATION	AFTER-TAX EQUITY CASH FLOW
1988	10564.	19363.	8800.	1055.	4287.	7071.	5932.	9114.	4610.	6181.	9918.	4528.	5027.
1989	11484.	22068.	10584.	1046.	6288.	8959.	7820.	8549.	5460.	6670.	9066.	5268.	5616.
1990	12498.	25158.	12661.	1036.	6002.	9850.	8710.	8027.	4521.	6327.	8300.	4284.	5301.
1991	13613.	28689.	15076.	1025.	6102.	11052.	9912.	7544.	3894.	6125.	7609.	3624.	5113.
1992	14842.	32724.	17882.	1012.	6002.	12448.	11359.	7097.	3354.	5952.	6986.	3066.	4943.
1993	16197.	37336.	21139.	998.	0.	11069.	9929.	6682.	412.	4567.	6422.	370.	3678.
1994	17690.	42607.	24916.	982.	0.	12949.	11810.	6297.	350.	4610.	5911.	308.	3707.
1995	19338.	48632.	29294.	965.	0.	15130.	13990.	5939.	296.	4647.	5448.	257.	3722.
1996	21157.	55521.	34364.	946.	0.	17655.	16516.	5607.	251.	4679.	5027.	213.	3724.
1997	23165.	63397.	40232.	925.	0.	20578.	19439.	5297.	211.	4705.	4644.	177.	3714.
1998	25384.	72402.	47019.	901.	0.	23960.	22821.	5008.	178.	4727.	4295.	146.	3695.
1999	27836.	82701.	54865.	875.	0.	27870.	26731.	4738.	149.	4744.	3976.	120.	3668.
2000	30547.	94478.	63931.	846.	0.	32388.	31249.	4486.	124.	4757.	3685.	98.	3634.
2001	33546.	107947.	74401.	814.	0.	37607.	36468.	4251.	103.	4765.	3418.	80.	3594.
2002	36865.	123352.	86487.	778.	0.	43633.	42493.	4031.	85.	4778.	3174.	65.	3549.
2003	40539.	140973.	100434.	738.	0.	50586.	49447.	3824.	70.	4772.	2950.	52.	3500.
.	.	.	.	.	.	.	.	.	.	.	.	.	.
.	.	.	.	.	.	.	.	.	.	.	.	.	.
.	.	.	.	.	.	.	.	.	.	.	.	.	.
2012	97911.	470830.	372919.	113.	0.	186516.	185377.	2448.	3.	4663.	1581.	2.	2958.
TOTAL	967835.	3626432.	2658598.	18888.	28583.	1353034.	1324552.	123470.	24289.	125460.	109805.	22813.	95058.

ANALYSIS USING WEIGHTED COST OF CAPITAL (STARTUP YEAR DOLLARS)

MINIMUM REVENUE REQUIREMENTS	PRESENT VALUE	= $159057.	THOUSAND
	UNIT PRESENT VALUE	= $ 7.26	PER MILLION BTU
	LEVELIZED COST ***	= $ 16641.	THOUSAND
	UNIT LEVELIZED COST	= $ 10.00	PER MILLION BTU
	SAVINGS/INVESTMENT RATIO	= 4.19	
	SIMPLE PAYBACK PERIOD	= 3.4	YEARS
	DISCOUNTED PAYBACK PERIOD	= 4.8	YEARS

ANALYSIS USING RETURN ON EQUITY (STARTUP YEAR DOLLARS)

MINIMUM REVENUE REQUIREMENTS	PRESENT VALUE	= $133907.	THOUSAND
	UNIT PRESENT VALUE	= $ 6.11	PER MILLION BTU
	LEVELIZED COST ****	= $ 16274.	THOUSAND
	UNIT LEVELIZED COST	= $ 10.58	PER MILLION BTU
	SAVINGS/INVESTMENT RATIO	= 4.67	
	SIMPLE PAYBACK PERIOD	= 2.8	YEARS
	DISCOUNTED PAYBACK PERIOD	= 3.9	YEARS

* PRESENT VALUE AT STARTUP USING WEIGHTED COST OF CAPITAL = 15.90 PERCENT PER YEAR
** PRESENT VALUE AT STARTUP USING RETURN ON EQUITY = 18.00 PERCENT PER YEAR
*** LEVELIZED COSTS ARE IN CONSTANT STARTUP DOLLARS. TO CONVERT TO CURRENT DOLLARS MULTIPLY BY 1.559
**** LEVELIZED COSTS ARE IN CONSTANT STARTUP DOLLARS. TO CONVERT TO CURRENT DOLLARS MULTIPLY BY 1.505

column contains the present value of interest plus tax depreciation. The fourteenth column contains the present value of the after-tax equity cash flow.

The bottom of the report contains financial statistics calculated from the year-by-year amounts and totals from the upper part of the report. First, coal-use project minimum revenue requirements are presented. Present values, unit present values, levelized costs, and unit levelized costs are shown. These are followed by the investment ratio, the simple payback period, and the discounted payback period resulting from the cost and benefit analysis. Statistics calculated with both discount factors are included.

4.3.3 Reports 11 and 12 - Minimum Revenue Requirements

Tables 4-11 and 4-12 show Reports 11 and 12, which contain display year minimum revenue requirements built up from separate categories of cost. Report 11 shows the results of discounting with the weighted cost of capital. Report 12 shows the results of discounting with the return on equity. The reports show the elements that are included in the financing-related capital charge, and the labor, material, and purchased energy elements included in operating and maintenance costs. Column headings include costs, discount factors, present values, unit present values, levelizing factors, levelized costs, and unit levelized costs.

4.4 SUMMARIES AND COMPARISONS

This section describes the two summary reports generated by the coal-use economics methodology to compare the effect of differing venture structures on a project. One report or the other will be printed in a given run, depending on the commercial structure selected by the user.

4.4.1 Report 13 - Comparison of Navy Financed/Navy Operated and Third Party Financed/Navy Operated Ventures

Table 4-13 shows Report 13, which compares financial statistics for Navy financing with those for third party financing. The top half of the report treats Navy financing; the bottom half treats third party

Table 4-11

Report 11-

PRIVATE VENTURE MINIMUM REVENUE REQUIREMENTS
DISCOUNTING WITH WEIGHTED COST OF CAPITAL

(COSTS IN NOVEMBER 1982 DOLLARS)

	COST (1000 $)	DISCOUNT FACTOR	PRESENT VALUE (1000 $)	UNIT PRESENT VALUE * ($/MILLION BTU)	LEVELIZING FACTOR	LEVELIZED COST ** (1000 $)	UNIT LEVELIZED COST *** ($/MILLION BTU)
CAPITAL							
ANNUAL RETURN TO INVESTORS	2341.	6.1164	14316.	.65	1.0000	2341.	2.67
ANNUAL CORPORATE INCOME TAXES	442.	6.1164	2701.	.12	1.0000	442.	.50
ANNUAL PROPERTY TAXES, INSURANCE	287.	6.1164	1756.	.08	1.0000	287.	.33
TOTAL CAPITAL CHARGES	3069.		18772.	.86		3069.	3.50
OPERATING (1987 - 2012)							
LABOR	1703.	6.1164	10413.	.48	1.0000	1703.	1.94
OPERATING + MAINTENANCE MATERIAL	1162.	6.1164	7109.	.32	1.0000	1162.	1.33
ELECTRICITY	256.	14.6643	3759.	.17	2.3975	615.	.70
GAS	19.	27.8883	544.	.02	4.5596	89.	.10
STEAM	17.	14.6643	252.	.01	2.3975	41.	.05
OIL	23.	20.1042	462.	.02	3.2869	76.	.09
COAL	2762.	12.5810	34745.	1.59	2.0569	5681.	6.48
TOTAL OPERATING			57284.	2.62		9366.	10.69
TOTAL LIFE CYCLE COST			76056.	3.47		12435.	14.20

* UNIT PRESENT VALUE BASED ON 21900. BILLION BTU HEAT TRANSFERRED OVER 25.0 YEARS OF LIFE

** LEVELIZED COST IN CONSTANT DISPLAY DOLLARS. TO CONVERT TO CURRENT DOLLARS MULTIPLY BY 2.086

*** CONSTANT DOLLAR UNIT LEVELIZED COST BASED ON 876.00 BILLION BTU HEAT TRANSFERRED PER YEAR

Table 4-12

Report 12-

PRIVATE VENTURE MINIMUM REVENUE REQUIREMENTS
DISCOUNTING WITH RETURN ON EQUITY

(COSTS IN NOVEMBER 1982 DOLLARS)

	EQUITY COST (1000 $)	DISCOUNT FACTOR	PRESENT VALUE (1000 $)	UNIT PRESENT VALUE * ($/MILLION BTU)	LEVELIZING FACTOR	LEVELIZED COST ** (1000 $)	UNIT LEVELIZED COST *** ($/MILLION BTU)
CAPITAL							
ANNUAL RETURN TO EQUITY HOLDERS	1847.	4.8132	8892.	.41	1.0000	1847.	2.11
ANNUAL DEBT SERVICE	566.	4.8132	2723.	.12	1.0000	566.	.65
ANNUAL CORPORATE INCOME TAXES	341.	4.8132	1643.	.08	1.0000	341.	.39
ANNUAL PROPERTY TAXES, INSURANCE	297.	4.8132	1431.	.07	1.0000	297.	.34
TOTAL CAPITAL CHARGES	3052.		14689.	.67		3052.	3.48
OPERATING (1987 - 2012)							
LABOR	1703.	4.8132	8194.	.37	1.0000	1703.	1.94
OPERATING + MAINTENANCE MATERIAL	1162.	4.8132	5595.	.26	1.0000	1162.	1.33
ELECTRICITY	256.	11.0111	2822.	.13	2.2877	586.	.67
GAS	19.	20.2416	395.	.02	4.2654	82.	.09
STEAM	17.	11.0111	189.	.01	2.2877	39.	.04
OIL	23.	14.8424	341.	.02	3.0837	71.	.08
COAL	2762.	9.5257	26307.	1.20	1.9791	5466.	6.24
TOTAL OPERATING			43844.	2.00		9189.	10.48
TOTAL LIFE CYCLE COST			58532.	2.67		12161.	13.88

* UNIT PRESENT VALUE BASED ON 21900. BILLION BTU HEAT TRANSFERRED OVER 25.0 YEARS OF LIFE

** LEVELIZED COST IN CONSTANT DISPLAY DOLLARS. TO CONVERT TO CURRENT DOLLARS MULTIPLY BY 2.014

*** CONSTANT DOLLAR UNIT LEVELIZED COST BASED ON 876.00 BILLION BTU HEAT TRANSFERRED PER YEAR

Table 4-13

Report 13 -

SUMMARY:

NAVY FINANCED/NAVY OPERATED VENTURE VS. THIRD PARTY FINANCED/NAVY OPERATED VENTURE

	PRESENT VALUE REFERENCED TO DISPLAY YEAR (11/1982)	PRESENT VALUE REFERENCED TO STARTUP YEAR (11/1987)
NAVY FINANCED/NAVY OPERATED VENTURE:		
PRESENT VALUE	$ 70130. THOUSAND	$151145. THOUSAND
UNIT PRESENT VALUE	$ 3.20 PER MILLION BTU	$ 6.90 PER MILLION BTU
LEVELIZED COST	$ 11859. THOUSAND	$ 15870. THOUSAND
UNIT LEVELIZED COST	$ 13.54 PER MILLION BTU	$ 18.12 PER MILLION BTU
SAVINGS/INVESTMENT RATIO	6.08	
DISCOUNTED PAYBACK PERIOD	4.3 YEARS	
THIRD PARTY FINANCED/NAVY OPERATED VENTURE:		
NAVY OPERATOR		
PRESENT VALUE	$ 69888. THOUSAND	$150624. THOUSAND
UNIT PRESENT VALUE	$ 3.19 PER MILLION BTU	$ 6.88 PER MILLION BTU
LEVELIZED COST	$ 11818. THOUSAND	$ 15816. THOUSAND
UNIT LEVELIZED COST	$ 13.49 PER MILLION BTU	$ 18.05 PER MILLION BTU
SAVINGS/INVESTMENT RATIO	6.18	
DISCOUNTED PAYBACK PERIOD	4.2 YEARS	
PRIVATE INVESTOR		
LEVELIZED REVENUE (LEASE)	$ 6354. THOUSAND PER YEAR	
LEASE LIFE	15 YEARS	

financing. The statistics, already displayed in previous reports, are redisplayed in this summary in both display and startup year dollars. All statistics are calculated with Navy economics. The third-party lease cost and lease life are shown.

4.4.2 Report 14 - Comparison of Navy Financed/Navy Operated and Third Party Financed/Third Party Operated (All Private) Ventures

Table 4-14 shows Report 14, which compares financial statistics for Navy financing with those for private financing. The top half of the report treats the Navy project; the bottom half treats the private project. The statistics, already displayed in previous reports, are redisplayed in this summary in both display and startup year dollars. Statistics for the all-Navy venture are calculated with Navy economics. Statistics for the all-private venture are calculated with commercial economics, using both the weighted cost of capital and the return on equity as discount factors.

Table 4-14

Report 14

SUMMARY:

NAVY FINANCED/NAVY OPERATED VENTURE VS. THIRD PARTY FINANCED/THIRD PARTY OPERATED (ALL PRIVATE) VENTURE

	PRESENT VALUE REFERENCED TO DISPLAY YEAR (11/1982)	PRESENT VALUE REFERENCED TO STARTUP YEAR (11/1987)
NAVY FINANCED/NAVY OPERATED VENTURE:		
PRESENT VALUE	$ 70130. THOUSAND	$151145. THOUSAND
UNIT PRESENT VALUE	$ 3.20 PER MILLION BTU	$ 6.90 PER MILLION BTU
LEVELIZED COST	$ 11859. THOUSAND	$ 15870. THOUSAND
UNIT LEVELIZED COST	$ 13.54 PER MILLION BTU	$ 18.12 PER MILLION BTU
SAVINGS/INVESTMENT RATIO	6.88	
DISCOUNTED PAYBACK PERIOD	4.3 YEARS	
THIRD PARTY FINANCED/THIRD PARTY OPERATED (ALL PRIVATE) VENTURE:		
AFTER-TAX NET CASH FLOW ANALYSIS DISCOUNTING WITH WEIGHTED COST OF CAPITAL		
PRESENT VALUE OF MINIMUM REVENUE REQUIREMENT	$ 76056. THOUSAND	$159057. THOUSAND
UNIT PRESENT VALUE	$ 3.47 PER MILLION BTU	$ 7.26 PER MILLION BTU
LEVELIZED COST (REAL $)	$ 12435. THOUSAND	$ 16641. THOUSAND
UNIT LEVELIZED COST	$ 14.20 PER MILLION BTU	$ 19.00 PER MILLION BTU
SAVINGS/INVESTMENT RATIO	4.19	
SIMPLE PAYBACK PERIOD	3.4 YEARS	
DISCOUNTED PAYBACK PERIOD	4.8 YEARS	
AFTER-TAX EQUITY CASH FLOW ANALYSIS DISCOUNTING WITH RETURN ON EQUITY		
PRESENT VALUE OF MINIMUM REVENUE REQUIREMENT	$ 58532. THOUSAND	$133987. THOUSAND
UNIT PRESENT VALUE	$ 2.67 PER MILLION BTU	$ 6.11 PER MILLION BTU
LEVELIZED COST (REAL $)	$ 12161. THOUSAND	$ 16274. THOUSAND
UNIT LEVELIZED COST	$ 13.98 PER MILLION BTU	$ 18.58 PER MILLION BTU
SAVINGS/INVESTMENT RATIO	4.67	
SIMPLE PAYBACK PERIOD	2.8 YEARS	
DISCOUNTED PAYBACK PERIOD	3.9 YEARS	

Section 5

NONPROFIT ENTITY PROJECTS

The coal-use economics methodology can be applied in either of two ways to projects undertaken by nonprofit entities such as universities and state and local governments:

- For nonprofit financed/nonprofit operated ventures, substitute nonprofit parameters for commercial data, as follows:
  - Set the income tax rate equal to zero.
  - Set the property tax and insurance rate to reflect insurance costs only.
  - Set capital structure data to reflect the source of funds, e.g., 100 percent debt at 9 percent/year, or 50 percent equity portfolio at 12 percent/year when inflation is 6 percent/year.
  - Input no depreciation information. Default values will be supplied by the program and ignored by the calculations.

This method will give results for all-Navy and all-nonprofit venture structures side by side. The nonprofit venture will be labeled "private venture."

For profit-making, third party financed/nonprofit operated ventures, choose input data as follows:

- Insert the nonprofit constant dollar discount rate in place of the Navy discount rate.
- Insert capital structure and depreciation data appropriate to the profit-making third party, and indicate the third party lease life.

This method will give results for all nonprofit and third party venture structures side by side, with nonprofit statistics generated instead of Navy statistics. The reports will be labeled "Navy." An appropriate

annual capital charge for property taxes and insurance must be calculated and added by hand to the levelized costs. To find the Navy equivalents to the two nonprofit reports generated by this method, the calculation must be rerun using the Navy constant dollar discount rate (the default is 10 percent).

REFERENCES

1-1 Economic Analysis Handbook, P-442, Naval Facilities Engineering Command, 1975.

1-2 Slaminski, J. M., "Economic Analysis and Priority Rating Formulation for Navy Shore Facilities Energy R&D Projects," Civil Engineering Laboratory, Naval Construction Battalion Center, Port Hueneme, California, November 1977.

1-3 Instruction for Preparation of Economic Analyses, LANTNAVFACENGCOM, 407:ARM, March 19, 1980.

1-4 Ward, Carter J., "Simplified Economic Analysis for Navy Shore Facilities Energy R&D Products," Civil Engineering Laboratory, Naval Construction Battalion Center, Port Hueneme, California, December 11, 1979.

1-5 "Energy Escalation Rates for Short Term Costing and Life Cycle Costing," Draft, August 23, 1976.

1-6 Coal Conversion Cost Computer Program, Peter F. Loftus Corporation, Pittsburgh, Pennsylvania, Draft NCEL Contract Report, Contract N62474-81-C9409, September 1982.

3-1 Paul H. Jeynes, Profitability and Economic Choice, Ames, Iowa, the Iowa State University Press, 1968.

3-2 Technical Assessment Guide, Special Report, EPRI PS-1201-SR, Electric Power Research Institute, Palo Alto, California, July 1979.

4-1 COALR - Coal Conversion Cost Reformulation Program: User Manual, Bechtel Group, Inc., San Francisco, California, Draft NCEL Contract Report, Contract N62474-82-C-8290, September 1983.

COMPUTER PROGRAM
USER MANUAL

COALR -
COAL CONVERSION COST
REFORMULATION PROGRAM

CONTENTS

TABLES

ILLUSTRATIONS

Section 1

PROGRAM CAPABILITY

1.1 PROGRAM DESCRIPTION

COALR - Coal Conversion Cost Reformulation Program - is a computer program prepared for the Naval Civil Engineering Laboratory (NCEL), Port Hueneme, California, by Bechtel Group, Inc., as part of the work of Phase I of "Engineering Services for Coal Conversion Guidance," Navy Contract N62474-82-C-8290. COALR incorporates the coal-use economics methodology prepared in the Phase I work. COALR was constructed by adapting an existing NCEL computer program.

COALR accepts as program input coal-use project costs estimated in the dollars of some reference year. The program then reformulates the project costs to the dollars of a user-chosen display year. Finally, the program calculates life cycle costs and financial statistics for the coal-use project. The operation of COALR is summarized in Figure 1-1.

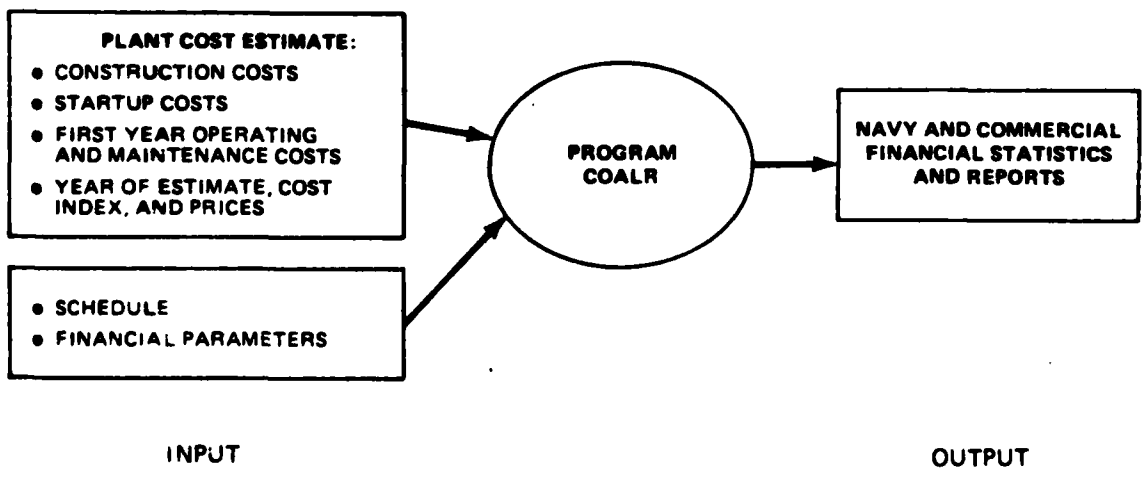


Figure 1-1 OPERATION OF PROGRAM COALR

1.2 PROGRAM FEATURES

COALR has been constructed as a versatile tool permitting the results of several different economic analyses to be viewed side by side. COALR has the following capabilities:

- Economic analyses using both Navy and commercial financial assumptions
- Presentation of seven financial statistics
- Treatment of three venture structures
- Reporting in both startup year and display year dollars
- Comparisons with use of fuel oil or natural gas

1.2.1 Navy and Commercial Economics

COALR includes both Navy and commercial economic analyses. Similarities between the two analyses are:

- Both are based upon computation of project present values using discount rates chosen by the user.
- Both aim to produce capital charge rates typical of those encountered in the private sector.

The two analyses differ principally in the way they take into account corporate income taxes paid by the private sector:

- The Navy economic analysis achieves the reality of private sector capital charges by using a discount rate that is an average of corporate gross profit rates since World War II. Use of this discount rate produces a single capital charge term that includes both return to investors and an allowance for corporate taxes. Since the Navy pays no income taxes, they are not calculated.
- The commercial economic analysis uses a discount rate that contains only return to investors, and use of this discount rate produces a capital charge term that contains only return to investors. To obtain a total capital charge, a term is added for the capital charge of corporate income taxes, calculated under present or previous tax laws for depreciation and investment credits.

1.2.2 Financial Statistics

COALR operates on project costs (capital and operating costs) to produce seven commonly occurring financial statistics for comparing energy project life cycle costs. These statistics are:

- Present value
- Unit present value
- Levelized cost
- Unit levelized cost
- Savings/investment ratio
- Discounted payback period
- Simple payback period

All seven statistics are calculated using commercial economics. The first six are also calculated using Navy economics. For both Navy and commercial economics the levelized costs and unit levelized are presented in constant (real) dollars.

1.2.3 Venture Structures

COALR treats the following three venture structures:

- Structure 1 - Navy financing/Navy operation
- Structure 2 - Third party financing/Navy operation
- Structure 3 - Third party financing/third party operation (all private)

Statistics for Structure 1 are calculated with Navy economics only. Statistics for Structure 2 are calculated using Navy economics, except for lease payments, which are determined by commercial economics. Statistics for Structure 3 are calculated entirely with commercial economics. Structure 3 can also be used for nonprofit organization projects by ignoring taxes.

1.2.4 Startup Year Versus Display Year Dollars

The financial statistics are presented in both plant startup year dollars and dollars of an arbitrary year selected by the user, called the display year. User purchased energy price input data is entered in display year dollars.

1.2.5 Comparisons with Use of Oil or Gas

COALR includes analyses of both the costs and benefits of displacing fuel oil or natural gas by a new coal-use project. The comparison analyses result in calculation of three of the financial statistics: the savings/investment ratio, the discounted payback period, and the simple payback period.

Figure 1-2 names the 14 possible reports generated by the Phase I program. The reports generated in a given run depend on the user-selected commercial venture option (third party financed or all private).

Figure 1-3 is a logic flow diagram which summarizes the financial calculations performed by COALR. First, subroutine CALCR reformulates the plant cost estimate to display year dollars. Then subroutine ECONR calls the financial subroutines which produce the output reports.

1.3 PROGRAM LIMITATIONS

COALR has the following limitations:

- The general inflation rate and energy commodity differential inflation rates are assumed constant during the coal-use project life cycle of construction and operation.
- The Navy discount rate and the commercial rates for interest on debt and return on equity are assumed constant during the coal-use project life cycle of construction and operation.
- The program compares the life cycle costs of the coal use project with the life cycle costs of a base case burning oil or gas in existing boilers. The base case does not include any capital costs to install new oil- or gas-fired boilers.

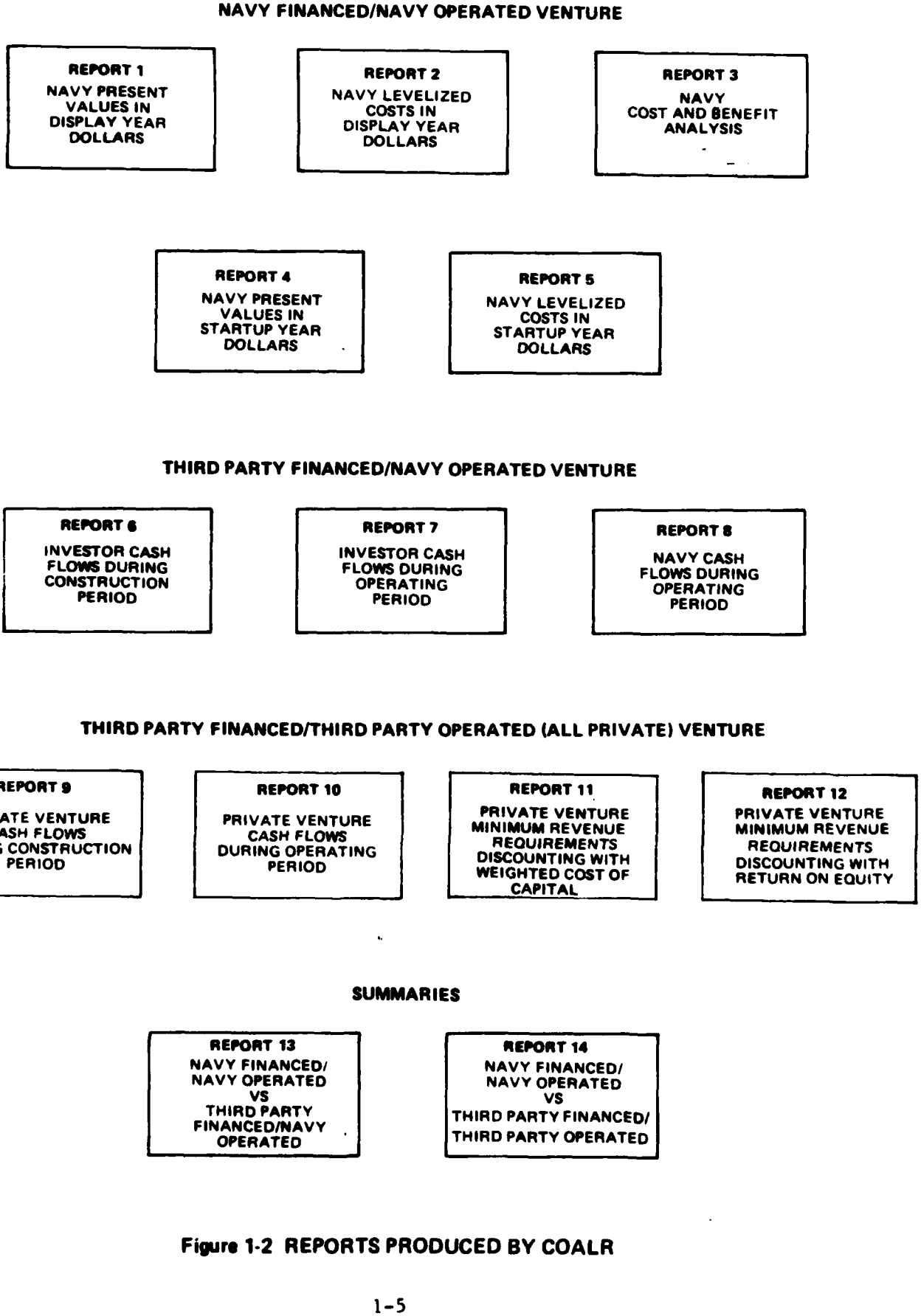


Figure 1-2 REPORTS PRODUCED BY COALR

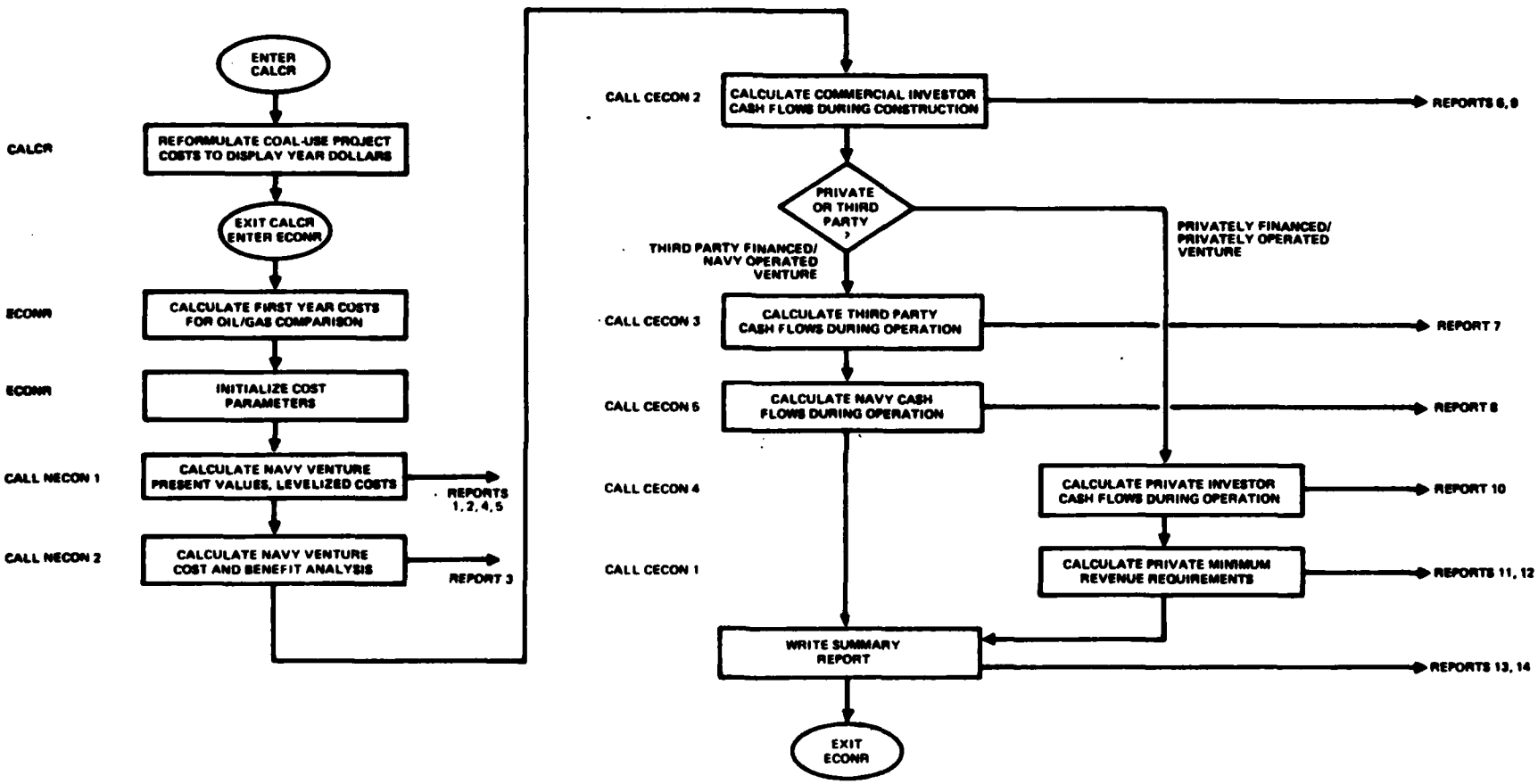


Figure 1-3 SUMMARY LOGIC FLOW DIAGRAM FOR FINANCIAL CALCULATIONS

Section 2

COMPUTATIONAL PROCEDURES

This section presents data and methodology sources for COALR and outlines the calculations used to produce the fourteen reports illustrated in Figure 1-2.

2.1 DATA AND METHODOLOGY SOURCES

The coal-use economics methodology used in COALR is described in Reference 2-1. Navy economic analysis methods are described in References 2-2 through 2-5. Commercial economic analysis methods, including formulas for compound interest factors, are described in Reference 2-6. Annual operating and maintenance costs for oil- and gas-fired comparison cases are taken from Reference 2-7.

2.2 SUMMARY OF COMPUTATIONAL PROCEDURES

The computational procedures of COALR are described below in a way that highlights similarities between Navy and commercial financial analyses. The following subjects are discussed:

- Input data reformulation, dealing with adjustment of the cost estimate reference time
- Treatment of discounting and inflation, dealing with present values, levelized costs, general inflation, and differential escalation
- Life cycle cost analyses, dealing with closed form annuity calculations, producing the following coal-use project financial statistics:
  - Total present value
  - Unit present value
  - Levelized costs
  - Unit levelized costs

- Private sector income taxes
- Analyses of costs and benefits, dealing with year-by-year calculations to produce the following financial statistics:
  - Savings/investment ratio
  - Discounted payback period
  - Simple payback period

2.3 INPUT DATA REFORMULATION

2.3.1 Reference Times

COALR works with the following three reference times:

- Base year - the year of the plant cost estimate
- Display year - a year chosen by the user for presentation of financial statistics
- Startup year - the year of plant startup

The user must specify the base year by providing the following cost parameters: plant cost index, hourly labor rate for operation and maintenance, and prices for purchased coal, electricity, fuel oil, natural gas, and auxiliary steam. These cost parameters are input by the user along with the cost estimate for plant installation and operation.

The display year and the startup year are selected by the user and are used as reference times for present value calculations in the financial analyses. To specify the selected display year, the user must input the following cost parameters: plant cost index, hourly labor rate for operating and maintenance, and prices for purchased coal, electricity, fuel oil, natural gas, and auxiliary steam.

The user is free to select a preferred plant cost index system, but once selected, the same system must be used in a given analysis.

2.3.2 Adjustment of Cost Estimate Reference Times

The first step performed by COALR is the conversion of the input cost estimate from base year dollars to display year dollars. This conversion (or reformulation) is performed in the following way:

- A ratio is formed for each cost parameter between the display year value (in the numerator) and the base year value (in the denominator).
- Construction, startup, and first year operating and maintenance material costs in the cost estimate are multiplied by the ratio of the plant cost indices for the display year (in the numerator) and the base year (in the denominator).
- Similarly, the first year purchased energy costs in the cost estimate are multiplied by the corresponding ratio of energy prices.

2.4 TREATMENT OF DISCOUNTING AND INFLATION

Once the cost estimate is available in display year dollars, COALR then distributes the capital and first year costs to their year of occurrence in plant construction and operation, and then discounts the costs to their present values at a "Year 0" reference time (the display year or startup year, depending on the section of the code). In performing the calculations, COALR makes frequent conversions between startup year and display year costs. In all of the calculations, user specified rates of inflation and differential inflation are taken into account.

2.4.1 Present Values

COALR includes calculation of present values with a Navy discount rate and two different private sector discount rates, all of which can be set by user input:

- Navy discount rate - a social opportunity cost which includes the equivalent of the return required by investors and an allowance for the capital charge associated with corporate income taxes.
- Return on equity - the return which private sector equity holders require on the equity portion of a private sector investment.

- Weighted cost of capital - the weighted average of private sector interest on debt and after-tax return required by equity holders. The weighted cost of capital is calculated from inputs of debt fraction, interest, and return on equity.

The present value of a construction period cash flow is the product of the amount of the cash flow and the discount factor for the year in which the cash flow occurs. According to the type of structure, the following conventions are used in COALR for timing a cash flow for a given year:

- Navy convention - the cash flow is distributed uniformly over the year
- Commercial convention - the cash flow is assumed to occur at the end of the year

The discount factor formulas for cash flow used by COALR are different in the two timing conventions.

COALR includes closed form calculations of the present value of a stream of equal cash flows recurring annually for N years, known as annuity. The total present value of an annuity is calculated as the product of the first year cash flow and a "cumulative uniform series" discount factor.

2.4.2 Levelized Costs

The present value statistic is also converted by COALR into a financially equivalent annuity known as levelized cost. Unit levelized costs (in dollars per million Btu of energy) are convenient because they can be validly compared with current prices for purchased energy in a noninflationary period.

The levelized cost is the best statistic for comparing Navy and commercial economic analyses, because in levelized costs the differences due to differing discount rates are minimized.

2.4.3 Effects of General Inflation

In COALR, a user-specified general inflation rate is assumed to remain constant throughout the life of a project to install and operate a plant.

To separate cost effects resulting from inflation from those which are independent of inflation, COALR distinguishes between costs in "current dollars" and those in "constant dollars":

- Current (inflating) dollar costs reflect changes which are to be paid at the time the costs are incurred. During inflationary periods, the prices of most commodities rise over time, so annually recurring costs will rise at or near the general inflation rate when expressed in current dollars.

- Constant (real) dollar costs reflect amounts that would be paid if the general prices and wage levels of a specific "Year 0" remained constant over time, as if general inflation were "turned off" at Year 0.

COALR relates the discount rate in current dollars to the discount rate in constant dollars according to the relation:

$$(1 + r_{cur}) = (1 + r_{const})\ (1 + g)$$

where:

r_{cur} = current dollar discount rate

r_{const} = constant dollar discount rate

g = rate of general inflation

Table 2-1 compares typical current dollar and constant dollar discount rates for the three types of discount rate when there is a 6 percent per year general inflation.

Present values at a Year 0 are calculated by either of the following methods when inflation is present:

- Costs in current dollars are discounted at the current dollar discount rate.

- Costs in constant dollars referenced to Year 0 are discounted at the constant dollar discount rate.

Table 2-1

TYPICAL CURRENT DOLLAR AND CONSTANT DOLLAR DISCOUNT RATES FOR 6 PERCENT PER YEAR GENERAL INFLATION

Type of Discount Rate	Current Dollar Discount Rate, percent/year	Constant Dollar Discount Rate, percent/year
Return on Equity	18.00	11.1
Weighted Cost of Capital	15.90(1)	9.3
Navy	16.60	10.0

(1) The 15.90 percent per year value represents a project capital structure containing 70 percent equity paying 18 percent per year and 30 percent debt paying 11 percent per year.

The present values calculated by the two methods are identical and COALR uses the two methods interchangeably.

Consistent with Navy convention, levelized costs are calculated in constant dollars in COALR.

Startup year present values are converted to display year present values in COALR by discounting at the current dollar discount rate. Startup year levelized costs are converted to display year levelized costs by de-escalating at the general inflation rate.

2.4.4 Differential Inflation of Purchased Energy

To accommodate purchased energy prices which may increase faster than general inflation, COALR allows specification of a separate differential inflation rate (DIR) for each purchased energy commodity. The DIR is approximately the amount by which the commodity inflation rate exceeds the general inflation rate, and it is defined exactly by the relation:

$$DIR = \frac{1 + e}{1 + g} - 1$$

Here,

e = energy commodity inflation rate, decimal fraction per year

g = general inflation rate, decimal fraction per year

Typical DIR values for various purchased energy commodities are given in Table 2-2. COALR combines the DIR with the constant dollar discount rate "r" to obtain an effective discount rate "x" through the formula,

$$x = \frac{1 + r}{1 + DIR} - 1$$

This formula, the basis for tabulated discount factors in Reference 2-2, is used in both Navy and commercial life cycle cost analyses.

Table 2-2

TYPICAL DIFFERENTIAL INFLATION RATES
FOR ENERGY PURCHASED BY NAVY BASES

Type of Purchased Energy	Differential Inflation Rate (DIR)(1), percent/year
Coal	5
Electricity	6
Steam	6
Fuel Oil	8
Natural Gas	10

(1) The DIR values shown are those recommended in Reference 1-5.

2.5 PROJECT LIFE CYCLE COSTS

COALR calculates the following four economic statistics from the costs of plant construction and operation:

- Present value
- Unit present value
- Levelized cost
- Unit levelized cost

These calculations consider only costs, and do not consider cash flows of income for sale of the products of the plant. The resulting financial statistics are called life cycle costs. In the private sector analysis they measure the minimum revenues the plant must earn through sale of products to pay all expenses and taxes and to pay investors the minimum return that they require. The Navy analysis leads to comparable life cycle costs.

Figure 2-1 is the cost cash flow diagram for a typical coal-use project for calculations with Year 0 as the startup year.

Construction period costs include the year-by-year construction costs and the startup (or owner's) costs incurred the last construction year. In commercial economic analyses, construction period costs are reduced by an investment tax credit. The present value of all construction period cash flows in startup year dollars is the total capital investment for the project.

Operating period costs, treated separately by COALR, include the following cost items:

- Operating and maintenance labor
- Operating and maintenance materials
- Coal
- Auxiliary electricity
- Auxiliary oil
- Auxiliary natural gas
- Auxiliary steam

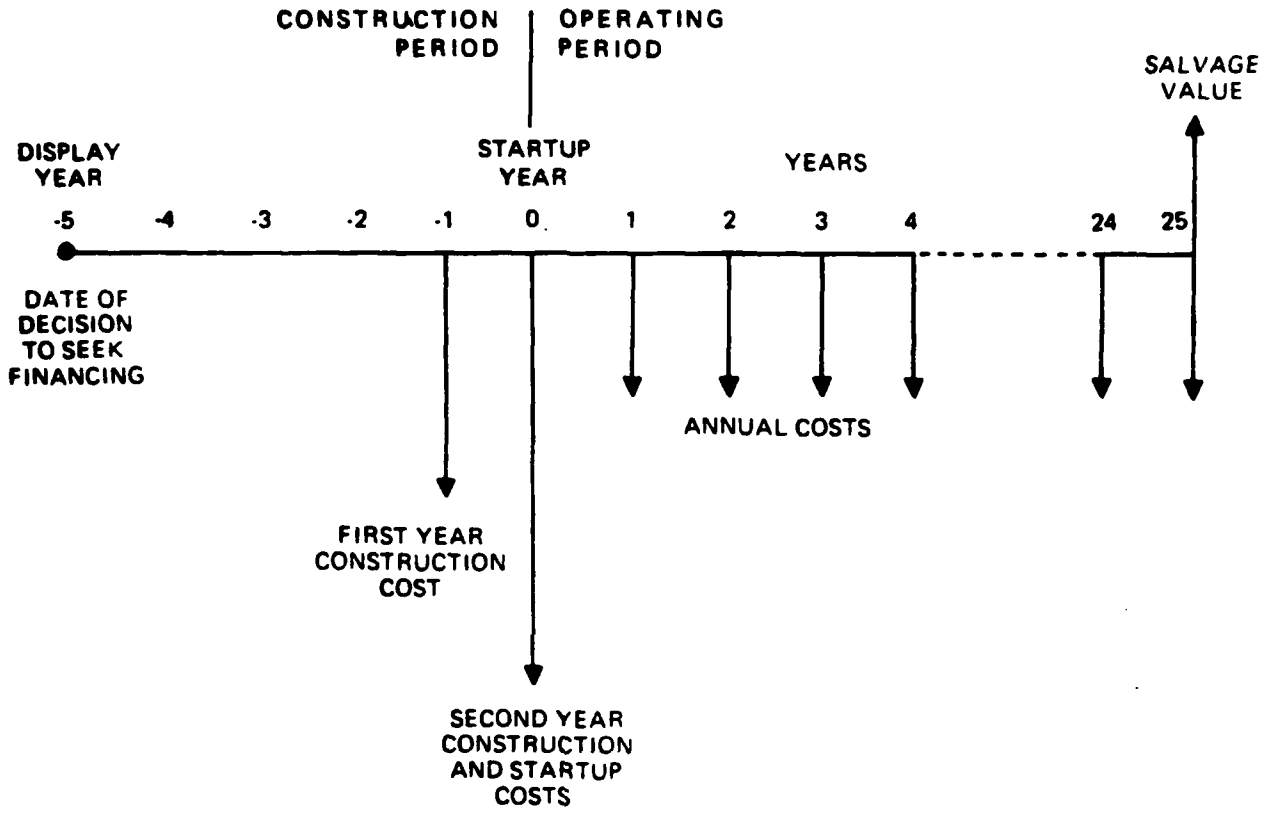


Figure 2-1 TYPICAL COST CASH FLOW DIAGRAM OF COAL CONVERSION PROJECTS

The present values of the operating period costs are calculated and summed to yield a total present value for operating and maintenance. COALR assumes that the plant will operate at the same load factor each year of its specified economic life.

If there is salvage value at the end of the operating period, its present value is a negative entry in computing the total present value of project costs.

Levelized life cycle costs are calculated from the construction period present values and the operating period present values. The resulting costs associated with the investment appear as annual capital charges added to the levelized annual operating and maintenance costs.

The capital charge has similar magnitude in Navy and commercial economics, but it is calculated differently in the two analyses:

- In Navy economics, the capital charge is simply the levelized cost of the present value of the investment.
- In commercial economics, the capital charge is the sum of the following operating period levelized costs:
  - Return to equity holder
  - Debt service
  - Corporate income taxes
  - Property taxes and insurance

COALR includes property taxes and insurance for privately operated ventures but not for Navy operated ventures, since local taxes are not levied on government land, and insurance is not usually included in Navy economic analyses. The annual property tax and insurance are typically 2 percent of the total capital requirement.

2.6 PRIVATE SECTOR INCOME TAXES

When calculating commercial minimum revenue requirements, COALR calculates federal and state corporate income taxes as a function of the minimum revenue requirement for return to investors (the "after-tax cash flow") by the following tax formula:

$$T = \frac{t}{1 - t} \quad (A - D - I)$$

where

T = annual corporte income tax

t = the tax rate, typically 50 percent

A = annual after-tax cash flow

D = annual capital depreciation for tax purposes

I = annual interest paid on debt

Since capital depreciation and interest payments vary from year to year, COALR performs a year-by-year calculation to determine the corresponding tax and its present value. The total life cycle present value of income tax is obtained by summation.

The capital depreciation for tax purposes is calculated in COALR by one of the following two methods, specified by the user (and summarized in Table 2-3):

- Sum-of-the-Years-Digits (SOYD), in use for several decades
- Accelerated Cost Recovery System (ACRS), introduced recently

COALR calculates interest on debt on a year-by-year basis assuming constant annual payments for debt service (the sum of interest and principal).

Table 2-3

METHODS FOR CALCULATING CAPITAL DEPRECIATION FOR TAX PURPOSES

Item

Definition of Tax Depreciable Capital

Notation

TDC = Tax Depreciable Capital, dollars
CC = Construction Cost, dollars
IDC = Interest During Construction, dollars
SC = Startup (Owner's) Costs, dollars(1)
ITC = Investment Tax Credit, dollars(2)

Annual Depreciable Deduction

Notation

ADD = Annual Depreciation Deduction, dollars
TDC = Tax Depreciable Capital, dollars
DF = Depreciation Factor
N = Depreciation Life, years
n = Year of Payment

Depreciation Life Selection

Method 1 - Sum of the Years Digits

TDC = CC + IDC + 0.4 SC

ADD = TDC · DF

$$DF = \frac{N - n + 1}{N(N + 1)/2} \quad \text{for } n \leq N$$

DF = 0 for n > N

N may be any integer

Method 2 - Accelerated Capital Recovery System

TDC = CC + IDC + 0.4 SC - 0.5 ITC

ADD = TDC · DF

Table of Depreciation Factors (DF)

	Year of Payment n														
N	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
3	.25	.38	.37	0	0	0	0	0	0	0	0	0	0	0	0
5	.15	.22	.21	.21	.21	0	0	0	0	0	0	0	0	0	0
10	.08	.14	.12	.10	.10	.10	.09	.09	.09	.09	0	0	0	0	0
15	.05	.10	.09	.08	.07	.07	.06	.06	.06	.06	.06	.06	.06	.06	.06

DF is zero for all n greater than 15

Allowed values of N are 3, 5, 10, and 15

Methodology selects next lower allowed N if input N is between allowed N

N = 3 applies to vehicles
N = 5 applies to third party and most private ventures
N = 10 and N = 15 apply to utilities and long-life private ventures

(1) Startup (Owner's) costs are assumed to include 60 percent depreciable capital and 40 percent nondepreciable capital.

(2) In the accelerated capital recovery system, half the investment tax credit must be subtracted in computing depreciable capital.

COALR permits the user to specify a percentage for an investment credit to reduce income tax during the construction period. This credit is subtracted from the total capital requirement to obtain the actual cost to investors.

2.7 ANALYSES OF COSTS AND BENEFITS

In addition to calculating the life cycle costs of a coal-use project, COALR compares the coal-use project with burning oil or gas in existing boilers in a year-by-year analysis of costs and benefits. The analyses of costs and benefits are carried out to calculate comparison financial statistics, which are the savings/investment ratio and payback periods.

2.7.1 Navy Comparison Statistics

In the Navy analysis, the operating costs that would be paid for the oil- or gas-burning unit are calculated as benefits to the coal-use project, since the coal-use project. The benefits occur during the operating period when oil or gas is displaced by the coal-use project. The year-by-year annual savings caused by the coal-use project are then calculated as the difference between the annual benefits and the annual coal-use project operating and maintenance costs. The present values of the savings in each year are then calculated. COALR finally calculates the savings/investment ratio and discounted payback period financial statistics in the following ways in the Navy analysis:

- The savings/investment ratio is the ratio of the total present value of savings to the total present value of the investment. If the savings/investment ratio exceeds 1.0, the coal-use project is financially attractive.

- The discounted payback period is the time until the cumulative present value of the savings becomes equal to the present value of the investment. If the discounted payback period is less than the operating life, the project is attractive.

2.7.2 Commercial Comparison Statistics

In the commercial economic analysis, the operating costs for burning oil or gas are considered as revenues for the coal-use project, under the assumption that the products of the coal-use project could be sold for the price of making them by burning oil or gas. The equivalent of "savings" in commercial economics is the after-tax cash flow.

COALR makes calculations of both of the following commercial economic equivalents of savings:

- The after-tax cash flow (common in the regulated electric utility industry)
- The equity after-tax cash flow (common in unregulated industries, such as petroleum)

The after-tax cash flow is:

$$A = (1 - t)(R - E) + tD + tI$$

where

A = annual after-tax cash flow

t = the tax rate

R = total annual revenues

E = annual expenses

D = annual capital depreciation for tax purposes

I = annual interest paid on debt

In the after-tax cash flow analysis of COALR, the present value of each annual after-tax cash flow is calculated year by year using the weighted cost of capital as the discount rate. Then COALR calculates savings/investment ratio, discounted payback period, and simple payback period financial statistics:

- The savings/investment ratio is the ratio of the total present value of operating period after-tax cash flows to the present value of the investment. As before, the coal-use project is economically attractive if the savings/investment ratio is greater than 1.0.

- The discounted payback period is the time until the cumulative present value of the after-tax cash flows becomes equal to the present value of the investment.

- The simple payback period is the time until the cumulative after-tax cash flow becomes equal to the present value of the investment.

The equity after-tax cash flow analysis in COALR differs from after-tax cash flow analysis in the following ways:

- The equity after-tax cash flow equals the after-tax cash flow minus debt service.

- Only the equity portion of the investment is used to compute the savings/investment ratio and payback periods.

- The discount rate is the return on equity.

Section 3

INPUT DESCRIPTION

This section describes the format, preparation, and use of the input data for COALR. Figure 3-1 is the complete set of input data for the first example run in Appendix A of this manual. Figure 3-1 is provided for reference during the discussions of this section. Input data for COALR may be prepared either as punched cards or as data files created from a time sharing terminal. In the discussion of this section, lines of input information are referred to as "cards," and the collection of input cards is referred to as the input "deck."

3.1 PROBLEM-ORIENTED UNFORMATTED INPUT

COALR employs an easy-to-use input system taken from a previous NCEL computer program developed by Peter F. Loftus Corporation (Ref. 3-1), which offers the following convenient features:

- A problem-oriented input language
- Unformatted data

Problem-Oriented Input Language. This includes division of the input deck into eight logically distinct data sections, and identifies input data by key words that serve both to document input variables for the user and to identify the variable to the program.

Four types of input information are supplied in the problem-oriented language:

- Declarations. Each declaration consists of a word or phrase called a "key word." The declaration stands alone, with no numerical values following. Each declaration sets a condition variable in the program.

```
*   EXAMPLR CASE 1
*
PLANT DATA
PEAK LOAD 200.   LOAD FACTOR .50
*
COAL DATA
PRICE 53.80   DIR 5.
*
UTILITY DATA
OIL 1.0876   DIR 8.
GAS 4.62   DIR 10.
ELECTRIC .06042   DIR 6.
STEAM 10.3   DIR 6.
MANHOURS 30.
*
ECONOMIC DATA
STARTUP YEAR 1987  MONTH 11
DISPLAY YEAR 1982  MONTH 11
COST INDEX 315.0
SCHEDULE 63.0 37.0
LIFE 25.  SALVAGE 0.   DISCOUNT 10.
*
REFORMULATION DATA
CONSTRUCTION 14950   INDEX 216.8
STARTUP 1640   INDEX 216.8
COAL 1540   RATE 30. * $/T
ELECTRIC 140   RATE .033 * $/KWH
GAS 10   RATE  2.37 * $/1000-SCF
OIL 10   RATE .4734 * $/GAL
STEAM 10   RATE 6.00 * $/1000-LB
LABOR 1135   RATE 20. * $/HR
OTHER ANNUAL 800   INDEX 216.8
*
COMPARISON DATA
BURN OIL
*
COMMERCIAL DATA
INFLATION 6.0
DEBT 30   INTEREST 11.   RETURN 18.
THIRD PARTY  LEASE LIFE 15.
INCOME TAX RATE 50. CREDIT 10
PROPERTY TAX PERCENT 2.
DEPRECIATION ACRS LIFE 5
*
END CASE
```

Figure 3-1 INPUT DATA

- Variables. Each variable consists of a word or phrase called a "key word," followed by one or more numerical values.

- Case Titles. A case title is supplied for each distinct case run.

- Comments. Comments aid user documentation and are ignored by the program.

In the discussion that follows, declarations and variables are referred to as "data items."

Unformatted Data. This feature relieves the user of concern about the column in which data is punched and allows the user freedom to provide information on one or several lines, and to include comment information on the same line as data. The input deck is processed by the Peter F. Loftus INFREE free-field input routine, which interprets information according to the following rules:

- Data may be punched anywhere on a data card.

- Data items may be key words or numbers.

- Data items are separated by a comma, an equal sign, and/or one or more blank spaces.

- Numeric items may be supplied with or without decimal points.

- Numbers in exponential format are supplied by adding a plus or a minus sign followed by the exponent (e.g., 3.4-2 for 3.4×10^{-2}).

- If an alphabetic item contains imbedded spaces, commas, or equal signs, or if it consists only of numbers and plus or minus signs, it should be enclosed by slashes (e.g.,/1A, BC DEF/ or /1234-71/).

- Data items may be repeated on a card by a specification of the form N*D, where N is the number of times data item D is to be repeated.

- Except for the title card, any cards with an asterisk (*) or dollar sign ($) in column 1 are treated as comment cards. Information on such a card is printed in the input echo portion of program output, but is ignored by the program.

- A data card may be terminated by an asterisk or dollar sign preceded and followed by a space. All information to the right of the asterisk or dollar sign on such a card is treated as a comment and will be printed in the input echo but will be ignored by the program.

- Data may be continued on more than one card by punching a blank followed by a plus sign (+) as the last data item on a card not including comments. For example, the following three cards:

```
      DEBT 30 +
INTEREST 11 +
  RETURN 18
```

are equivalent to

```
DEBT 30 INTEREST 11 RETURN 18
```

3.2 INPUT DECK ORGANIZATION

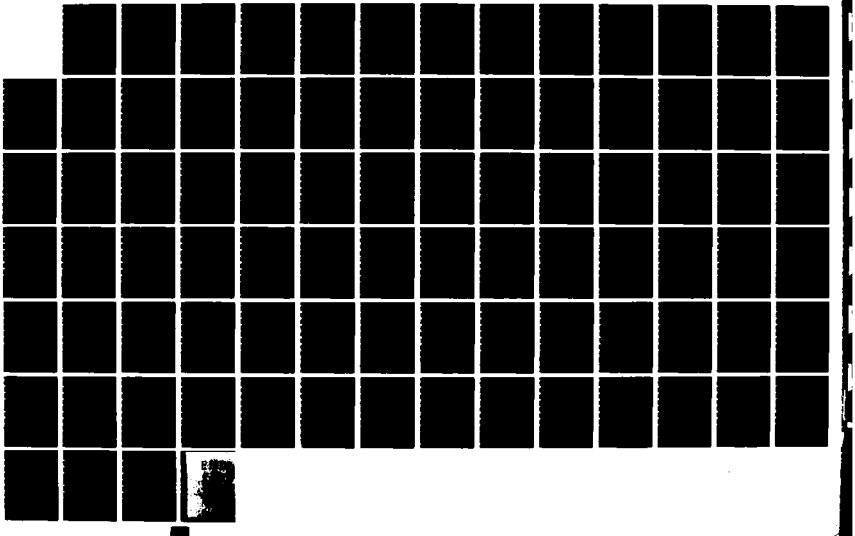
The input data deck for a given run (or "job") may contain a data set for a single case, or it may contain data sets for several cases to be processed in series. The data set for a case is terminated either by the declaration "END CASE" or by "END JOB." After the last data set of the run, supply "END JOB." After each prior data set, supply "END CASE."

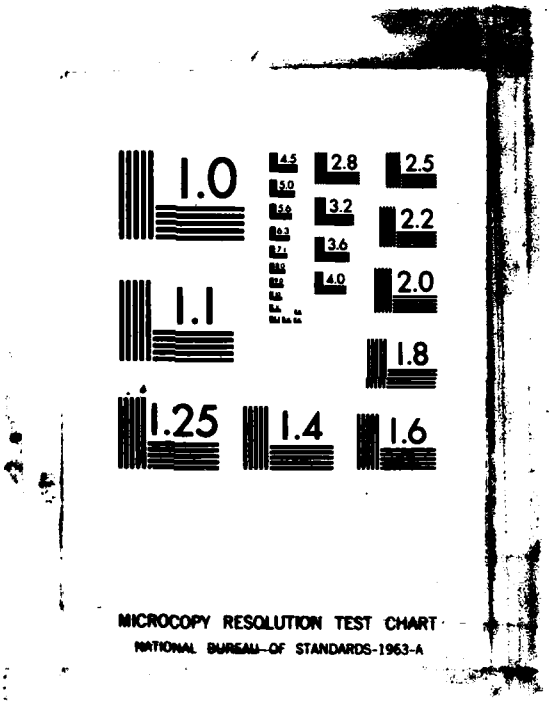
The data set for each case is divided into the following eight sections:

- Title and descriptive information
- Plant data
- Coal data
- Utility data
- Economic data
- Reformulation data
- Comparison data
- Commercial data

The title and descriptive information section must come first. The other sections may be presented in any order. Some sections may be omitted;

AD-A140 492 A COAL-USE ECONOMICS METHODOLOGY FOR NAVY BASES PHASE I 2/2
OF ENGINEERING SE..(U) BECHTEL GROUP INC SAN FRANCISCO
CA A I MCCONE ET AL. FEB 84 NCEL-CR-84.001
UNCLASSIFIED N62474-82-C-8290 F/G 10/1 NL




1.0
1.1
1.25
1.4
1.6
2.8
3.2
3.6
4.0
2.5
2.2
2.0
1.8
MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

such sections will be clearly noted in the descriptions below. Within a section, data items may be omitted unless otherwise noted. When a data item is to be omitted, both the key word and any numerical values following it should be omitted. The discussion below will indicate the default values of all variables.

3.3 TITLE AND DESCRIPTIVE INFORMATION

The title and descriptive information section must be the first section of a case data set. The first card must be the title card. It must have an asterisk (*) or dollar sign ($) in Column 1. The remaining columns of the card contain the title that will be printed at the top of output pages.

The user may put additional comment cards in this section to describe the case and the purpose of the run. These cards will appear in the input echo but will be ignored by the program

3.4 PLANT DATA

The first entry for the plant data section is the following declaration appearing by itself on the first card of the section:

PLANT DATA

The next card contains two variables as data items. The card is as follows, where r denotes a real number:

PEAK LOAD r1 LOAD FACTOR r2

The order of data items on the card is not important. If a data item is omitted, a default value is supplied by the program.

The definitions of the variables on the first card are as follows:

Key Word	Numerical Value	Definition	Units	Default Value
PEAK LOAD	r1	Peak heating steam load of the plant	1000-lb/hr	0.0
LOAD FACTOR	r2	Annual plant load factor	decimal fraction	0.0

Note that the information on card 1 could be placed on a single card, or could appear on two cards in any order.

3.5 COAL DATA

This section describes the coal to be used. The first card of the section must contain the declaration

COAL DATA

On a subsequent card in the section, the user supplies the following, where r signifies a real number:

PRICE r1 DIR r2

These variables are defined as follows:

Key Word	Numerical Value	Definition	Units	Default Value
PRICE	r1	Delivered price of coal	$/ton	0.0
DIR	r2	Differential inflation rate of coal	%/yr	0.0

3.6 UTILITY DATA

This section provides rate information for labor, purchased energy, water, and scrubber chemicals. The first card of the section must contain the following declaration:

UTILITY DATA

Subsequent cards that may be supplied are as follows, where r signifies a real number:

MANHOURS r1
ELECTRIC r2 DIR r6
GAS r3 DIR r7
OIL r4 DIR r8
STEAM r5 DIR r9

The rate variables in the cards above are defined as follows:

Key Word	Numerical Value	Definition	Units	Default Value
MANHOURS	r1	Labor rate	$/manhour	0.0
ELECTRIC	r2	Electricity rate	$/kWh	0.0
GAS	r3	Natural gas rate	$ per thousand standard cubic feet	0.0
OIL	r4	Fuel oil rate	$/gallon	0.0
STEAM	r5	Auxiliary steam rate	$/1000-lb	0.0

All rates must be in display year dollars. The key work DIR on the cards above denotes the differential inflation rate for the purchased energy commodity preceding it on the line. The numerical values r6, r7, r8, and r9 are expressed in percent per year.

The default value for each DIR is zero.

3.7 ECONOMIC DATA

This section describes economic parameters. The first card of this section contains the following declaration:

ECONOMIC DATA

Three cards must now be supplied. The data items on each card must be supplied in the order shown. The three cards are:

```
STARTUP YEAR  i1 MONTH i2
DISPLAY YEAR  i3 MONTH i4
COST INDEX    r1
```

In the above, i designates an integer and r designates a real number.

The integers on the first and second cards above are input as follows:

i1 - the startup year, in four digits
i2 - the startup month, an integer between 1 and 12
(if omitted, 1 is assumed)
i3 - the display year, in four digits
i4 - the display month, an integer between 1 and 12
(if omitted, 1 is assumed)

The cost index card presents a value for the cost index published by Chemical Engineering Magazine.

The number r1 on the cost index card is the display year value of the cost index.

Following the three cards above, a schedule card must be supplied. This card has the form:

```
SCHEDULE    r1 r2 r3 r4 r5
```

The numbers r1, r2, etc. are percentages of the construction costs in years preceding startup of plant operation, counting backwards from startup. The percentages must add up to 100 percent. For construction periods shorter than five years, only those percentages that are nonzero must be entered.

Three additional data items may be supplied on one or more card in any order. Shown on a single card, these are as follows:

LIFE r1 SALVAGE r2 DISCOUNT r3

Here, r designates a real number. The variables are defined as follows:

Key Word	Numerical Value	Definition	Units	Default Value
LIFE	r1	Economic life of the plant	Years	25.0
SALVAGE	r2	Salvage value of plant at end of economic life	Thousands of dollars	0.0
DISCOUNT	r3	Navy constant dollar discount rate	Percent/year	10.0

3.8 REFORMULATION DATA

This section presents coal-use project costs that will be reformulated by COALR. The first card of the section is the declaration:

REFORMULATION DATA

The following additional cards are then supplied, where r signifies a real number:

Construction	r1	INDEX	r10
Startup	r2	INDEX	r11
Coal	r3	RATE	r12
Electric	r4	RATE	r13
Gas	r5	RATE	r14
Oil	r6	RATE	r15
Steam	r7	RATE	r16
Labor	r8	RATE	r17
Other Annual	r9	INDEX	r18

The variables on the left are the coal-use project costs in the dollars of some reference year. The variables are defined as follows:

Key Word	Numerical Value	Definition	Units	Default Value
CONSTRUCTION	r1	Total construction cost	$1000	0.0
STARTUP	r2	Startup cost	$1000	(11 percent of construction)
COAL	r3	First year coal cost	$1000	0.0
ELECTRICITY	r4	First year electricity cost	$1000	0.0
GAS	r5	First year natural gas cost	$1000	0.0
OIL	r6	First year fuel oil cost	$1000	0.0
STEAM	r7	First year auxiliary steam cost	$1000	0.0
LABOR	r8	First year labor cost	$1000	0.0
OTHER ANNUAL	r9	First year material and subcontract costs	$1000	0.0

The variables to the right on the cards define price levels for the reference year of the project costs. These variables are defined as follows:

Key Word	Numerical Value	Definition	Units	Default Value
INDEX	r10	Cost index for construction	dimensionless	0.0
INDEX	r11	Cost index for startup	dimensionless	0.0
RATE	r12	Price of coal	$/ton	0.0
RATE	r13	Price of electricity	$/kWh	0.0
RATE	r14	Price of gas	$ per thousand standard cubic feet	0.0
RATE	r15	Price of oil	$/gallon	0.0
RATE	r16	Price of auxiliary steam	$/$10^3$ lb	0.0
RATE	r17	Price of labor (including benefits and supervision)	$/manhour	0.0
INDEX	r18	Cost index for first year material and subcontracts	dimensionless	0.0

The cost index to be used is that published by Chemical Engineering magazine. If a price level variable is 0.0, the program will assume that the corresponding project cost variable is in display year dollars.

3.9 COMPARISON DATA

This section determines the type of base case against which the coal-use plant is compared. The first card of this section contains the declaration:

COMPARISON DATA

The next card contains one of the following two alternative declarations:

Alternative Declaration	Interpretation
BURN OIL	A base case of burning fuel oil in existing boilers is selected.
BURN GAS	A base case of burning natural gas in existing boilers is selected.

3.10 COMMERCIAL DATA

This section describes private sector financial assumptions. The first card of this section contains the following declaration:

COMMERCIAL DATA

The second card of the section is:

INFLATION r1

Here, r1 is the general inflation rate in percent/year.

The third card of the section defines the private sector capital structure as follows:

DEBT r1 INTEREST r2 RETURN r3

Again, r signifies a real number. The variables are defined as follows:

Key Word	Numerical Value	Definition	Units	Default Value
DEBT	r1	The amount of the project capital that is financed by debt	Percent	30.0
INTEREST	r2	The current dollar rate of interest on debt	Percent per year	11.0
RETURN	r3	The current dollar rate of return on equity	Percent per year	18.0

The fourth card of the section contains one of the following two alternative declarations:

Alternative Declaration	Interpretation
PRIVATE	A venture structure is selected that is third party financed and third party operated (all private).
THIRD PARTY	A venture structure is selected that is third party financed and Navy operated.

If the third party alternative is selected, the following additional variable may be supplied on the same or following card:

```
LEASE LIFE r1
```

Here, r1 is the duration of the lease agreement between the third party and the Navy, expressed in years. The default value is 15 years.

The next two cards define tax information. They are of the following form, where r is a real number:

```
INCOME TAX RATE r1 CREDIT r2
PROPERTY TAX PERCENT r3
```

These variables are defined as follows:

Key Word	Numerical Value	Interpretation	Units	Default Value
INCOME TAX RATE	r1	Federal plus state corporate income tax rate	Percent of annual taxable income	50.0
CREDIT	r2	Investment tax credit	Percent of investment	10.0
PROPERTY TAX PERCENT	r3	Annual property tax rate	Percent of total capital requirement per year	2.0

The last card defines the calculation of depreciation for tax purposes. The card has the form:

DEPRECIATION a LIFE r1

In the above, a is one of the following two alternative declarations about the method for computing year-by-year depreciation:

Alternative Declaration	Interpretation
DEPRECIATION SOYD	The sum of the year's digits method is selected.
DEPRECIATION ACRS	The accelerated capital recovery method is selected. (The default is the ACRS method.)

On the last card above, the number r1 is the plant life for tax depreciation purposes, expressed in years. The default value is 5 years.

Section 4

PROGRAM OUTPUT

This section describes the output of COALR. The basis for the discussion in this section will be the example of the output of two typical run cases, selected to demonstrate both commercial options of the program. The outputs for these two cases are Tables A-1 and A-2 in Appendix A.

The output of the example run contains the following parts:

- An echo of input data
- Financial analysis reports

Each of these parts is described briefly below.

4.1 INPUT DATA ECHO

The first part of each output is the input data echo. The input data echo is divided into two segments:

- Blind echo
- Interpretive echo

The blind echo is merely an immediate reprinting in the output of the data fed in as input. The blind echoes of the example runs are shown on the first page of Table A-1 and the first page of Table A-2 under the heading "Input Data Listing." For both examples, the input was prepared in the sequence indicated in Section 3. The example input makes extensive use of comments in order to clearly label the units and interpret input variables and declarations. This procedure may be useful for other users.

The interpretive echo proves to the user that his input data has been correctly stored in program internal variables. In Table A-1 the interpretive echo is displayed in three pages.

4.2 FINANCIAL ANALYSIS REPORTS

The final part of the output presents the financial analyses reports generated by the coal-use economics methodology developed under Phase I of the contract (References 2-4 and 2-5). The last 9 pages of Table A-1 present the financial analysis reports generated for the first example case. The reports in Table A-1 describe the following two ventures which can be compared side-by-side:

- A Navy financed/Navy operated venture
- A third party financed/Navy operated venture

The titles of the reports in Table A-1 are as follows:

- Navy present values in display year dollars
- Navy levelized costs in display year dollars
- Navy life cycle cost and benefit analysis
- Navy present values in startup year dollars
- Navy levelized costs in startup year dollars
- Third party financing investor cash flows during contruction period
- Third party financing investor cash flows during operating period
- Third party financing Navy cash flows during operating period
- Summary: Navy financed/Navy operated venture vs. third party financed/Navy operated venture

The reports for the second case describe the followi g two ventures which can be compared side by side:

- A Navy financed/Navy operated venture
- A privately financed/privately operated venture

For the second example case, COALR generates the same Navy reports as in Table A-1. Table A-2 contains only resports for the second example case which are different from those in Table A-1. These are as follows:

- Private venture investor cash flows during construction period
- Private venture cash flows during operating period
- Private venture minimum revenue requirement discounting with weighted cost of capital
- Private venture minimum revenue requirement discounting with return on equity
- Summary: Navy financed/Navy operated venture vs privately financed/privately operated venture

Section 5

PROGRAM EXECUTION

This section presents instructions for executing COALR on the computer designated KWA at Control Data Corporation's Western Cybernet Center in Sunnyvale, California. Instructions are provided for execution in either of the following modes:

- Batch
- Demand (through the SUBMIT command)

Instructions are provided for the following three operations:

- Run COALR with user input cases
- Run COALR with EXAMPLR sample input cases
- Generate a compilation listing of COALR

The instructions for the operations above utilize the procedure file COALPRC, which is a permanent public file under user number L6016GS. Procedures in File COALPRC automatically retrieve program files, data tables, and sample and test input data from a program tape and provide routine control statements to complete a run.

5.1 BATCH MODE EXECUTION

Batch mode execution is accomplished by submission of a deck of run cards. This run deck consists of the following set of cards in the order shown:

- Identification cards
- Procedure cards
- An end-of-record card

- Input data cards
- An end-of-information card

Each of these is discussed below.

5.1.1 Identification Cards

Table 5-1 displays typical identification cards for use of COALR. The table provides a brief explanation of the contents of each card. This explanation is provided for information only. Since several of the cards are user-specific and installation-specific, the user must consult local Control Data Corporation representatives for assistance in preparing correct identification cards.

5.1.2 Procedure Cards

These cards will perform the required operations to run COALR. They are the same in batch and demand mode. They are discussed in Section 5.3.

5.1.3 End-of-Record Card

After the last procedure card, an end-of-record card must be placed. It consists of the numerals 7, 8, and 9 punched in column 1. It is used if input data cards follow.

5.1.4 Input Data Cards

User input data cards are placed after the end-of-record card. If the procedure needs no user input data, or if the required data is to be obtained from a disc file, no input cards are to be provided, and the preceding end-of-record card is deleted.

5.1.5 End-of-Information Card

After the last input data card (or last procedure card if there are no input data cards), an end-of-information card must be placed. It consists of the numerals 6, 7, 8, and 9 punched in column 1.

Table 5-1

TYPICAL BATCH MODE IDENTIFICATION CARDS

Card Number	Card Contents	Explanation
1	JOB,P4,T100,STKWA.	JOB indicates the start of information for a job. P4 indicates assignment of job priority 4. T100 indicates a limit of 100 seconds for the job. STKWA indicates that the job will utilize the Sunnyvale computer designated KWA. The terminal period indicates the end of the job control card. Each control card in a batch deck must end with a period.
2	USER,XX999YY,PASSWORD,KWA.	USER indicates that user identification data follows. XX999YY is a typical form of user number. PASSWORD is the user's password. KWA indicates that the user number is assigned to computer KWA.
3	CHARGE,WW9992Z,*QQ9*PN999.	CHARGE indicates that user accounting data follows. WW9992Z is a typical form of charge number. *QQ9*PN999 is a possible form of program and individual user number.
4	ROUTE,OUTPUT,DEF,DC=PR,ST=WCZ,UN=MKIVPW,FID=MYNAME.	ROUTE indicates that the output should be printed at a location other than the Sunnyvale computer center. OUTPUT is the name of the file to be routed. DEF indicates that routing is deferred until the run is complete. DC=PR indicates that the output device is a printer. ST=WCZ indicates the Sunnyvale output queue holding the output. UN=MKIVPW indicates that that the printer is in the San Francisco data center. FID=MYNAME indicates that MYNAME is to be printed on the output.
5	HEADING.M1MYNAME (This card is optional.)	HEADING indicates that a heading is to be printed on the first run page. The period after HEADING ends the heading command. M is the character used to print the heading. 1 indicates that the heading will be printed at the top of the next page. MYNAME is the heading to be printed, up to 10 characters; the user's name is the heading recommended.
6	GET,FILENAM. (This card is optional, and is used if input data is on disc rather than on cards.)	GET indicates that a data file is to be made a local file for the user's run. FILENAM is the name of the data file.

5.2 DEMAND MODE EXECUTION

Demand mode execution from a timesharing terminal is accomplished by the following steps:

- Creation of a disc file containing the job control statements
- Submission of the file as a remote batch job

5.2.1 Creation of Job Control File

From a timesharing terminal, the user can create a job control file using the text editor(1). The file may be of either of the following two forms:

- The statements and data lines are identical to the cards of the equivalent batch job deck.
- Most statements are identical to cards in the equivalent batch job deck. An interpretive feature permits substituting commands that may be shorter for some statements.

Table 5-2 describes a typical demand mode job control file that includes the interpretive feature. When working from the terminal, it is usually most convenient to prepare input data as a separate file rather than to include it in the job control file. In that case, the data file is brought into the job by the GET command shown in Tables 5-1 and 5-2.

5.2.2 Submission of Job Control File

Submission of the job from the terminal is accomplished by the lines shown in the following example:

```
GET,JCFILE
SUBMIT,JCFILE
```

(1) For instructions on the use of the XEDIT text editing system, the user should consult Control Data Corporation documentation.

Table 5-2

TYPICAL DEMAND MODE JOB CONTROL FILE

Line Number	Line Contents		Explanation
1	/JOB		This announces the use of the interpretive feature.
2	JOB,P4,T100.		This line is substituted for the batch mode JOB card.
3	/USER		This line commands the computer to retrieve user number, password, and computer assignment from the terminal session submitting the job.
4	/CHARGE		This line commands the computer to retrieve accounting data from the terminal session submitting the job.
5	ROUTE,OUTPUT,DEF,DC=PR,ST=WC2,UN=MKIVPW,FID=MYNAME.		These lines are identical to the corresponding batch mode cards.
6	READING.MlMYNAME	(Optional)	
7	GET,FILENAM.	(Optional)	
8,...,n	(Procedure lines)		These lines are identical to the corresponding batch mode cards.
n + 1	/EOR	(Optional)	This line substitutes for the end-of-record batch mode card.
n + 2,...,m	(Data lines)	(Optional)	These lines are identical to the corresponding batch mode cards.
m + 1	/EOF		This line substitutes for the end-of-information batch mode card.

In the first line, the GET command brings the disc file named JCFILE into the user's computer workspace. JCFILE is the file of job control statements. In the second line, the SUBMIT command submits file JCFILE as the job control statements for a remote batch job.

5.3 PROCEDURE STATEMENTS

Procedure file COALPRC contains a series of procedures to carry out operations with COALR. Brief procedure statements will then permit the user to execute the procedures. The following paragraphs explain the procedure statements for three operations with COALR.

5.3.1 Run with User Input Cases

To run COALR with input cases prepared by the user, include the following procedure statements as cards or file lines:

```
GET,COALPRC/UN=L6016GS.
BEGIN,RUSRDAT,COALPRC,I=FILENAM.
```

In the first card, the command GET makes the procedure file COALPRC a local file for the user's run. In the second card, the command BEGIN executes a procedure named RUSRDAT which is found in file COALPRC. FILENAM is the name of the user's file containing input cases. This file may be on disc, or it may be the file created when input data cards or lines are read into the computer with the job control deck.

5.3.2 Run with EXAMPLR Sample Input Case

The sample output of Appendix A is generated by a run with an input data file labeled EXAMPLR. To replicate that run, include the following procedure statements as cards or file lines:

```
GET,COALPRC/UN=L6016GS.
BEGIN,RXPLDAT,COALPRC.
```

In the first card, the command GET makes the procedure file COALPRC a local file for the user's run. In the second card, the command BEGIN executes a procedure named RXPLDAT which is found in file COALPRC.

5.3.3 Generation of Compilation Listing

To generate a compilation listing of COALR, include the following procedure statements as cards or file lines:

```
GET,COALPRC/UN=L6016GS
BEGIN,RLSTCOD,COALPRC.
```

In the first card, the command GET makes the procedure file COALPRC a local file for the user's run. In the second card, the command BEGIN executes a procedure named RLSTCOD which is found in file COALPRC.

5.4 RESOURCES REQUIRED TO EXECUTE PROCEDURES

Table 5-3 indicates the computer resources required to execute principal COALR procedures.

Table 5-3

COMPUTER RESOURCES REQUIRED
TO EXECUTE COALR PROCEDURES

Procedure Executed	Words of Core	Central Processor Time, Seconds	Billing Units	Input/ Output Data Blocks (1)
Run COALR with EXAMPLR as input (contains four cases)	51,300	15	13	120
Compile COALR	62,000	50	40	560

(1) One input/output data block consists of 1280 characters.

Section 6

ERROR PROCESSING

6.1 INPUT EDITING ERROR MESSAGES

Table 6-1 lists and interprets error messages that assist in assuring integrity of the input data. The input editing is performed by the program during a run. The occurrence of an error message indicates that the input should be corrected and a new run submitted.

6.2 CALCULATION ERROR MESSAGES

The program contains no error messages generated during calculations.

Table 6-1

INPUT ERROR MESSAGES

Message	Interpretation
Infree error character, n, "string"	The nth character in "string" cannot be interpreted
Error - cannot process word n on the above card	The nth word on the input card cannot be interpreted
Error - word n on the above card should be numeric	Self explanatory
Error - word n on the above card should be alphabetic	Self explanatory
Error - word n on the above card is missing	Self explanatory
Error - schedule values do not add up to 100 percent	The percents of spending during construction years do not total 100 percent. The life cycle costs will be erroneous

Section 7

TEST PROCEDURES

COALR was tested by detailed hand check of all major calculations and program options, and spot check of program logic and calculations in minor options.

Correct functioning is demonstrated for major options by the four sample cases in the EXAMPLR run in Appendix A, as shown in Table 7-1. The four sample cases generate all the reports available from COALR, and exercise the options that will be used most frequently. The calculations subjected to hand check for the major options are described in Table 7-2. The extensive intermediate details in the reports generated by COALR lend themselves to direct independent check, which the reader can reproduce.

Spot checks for minor options are described in Table 7-3. A special case run was made to test each minor option, and correct function was demonstrated.

Table 7-1

MAJOR OPTIONS DEMONSTRATED BY RUN EXAMPLR

Option Demonstrated	EXAMPLR CASE 1	2	3	4
Third party financed/Navy operated venture	X		X	X
Privately financed/privately operated ventures		X		
Depreciation calculated by the accelerated capital recovery system (ACRS)	X	X		X
Depreciation calculated by the sum-of-the-years-digits (SOYD) method			X	
Oil-fired base case	X	X	X	
Gas-fired base case				X

Table 7-2

CALCULATIONS VERIFIED BY HAND
CHECK FOR MAJOR PROGRAM OPTIONS

Calculation	Method of Verification
Reformulation of project cost data	Calculation of display year costs from indices, rates, input costs
Navy present values	Calculation of discount factors from formula, Navy tables (Ref. 7-1)
Navy levelized costs	Calculation of levelizing factors
Navy year-by-year costs and benefits analysis	Check calculations for first, last, and representative intermediate years; check of statistics formed from totals
Commercial cash flows during construction period	Check of all table entries
Third party cash flows during operating period	Check calculations for total levelized lease, and for first, last, and key intermediate years
Navy cash flows during operating period	Check of Navy present value of lease payments for key years, check of statistics formed from totals
Private venture cash flows during operating period	Check calculations for first, last, and key intermediate years; check of statistics formed from totals
Private venture minimum revenue requirements	Check of all present value and levelizing factors, check of all sums, products, and quotients
Summaries	Check of all table entries

Table 7-3

MINOR OPTIONS VERIFIED BY SPOT CHECK

Minor Option	Feature Verified
Non-zero salvage value	Correct treatment in each report
Display year that follows the startup year	Correct discount factors
Omitting several operating cost items from UTILITY DATA and REFORMULATION DATA	Correct default values
Cogeneration	Correct handling of net cogeneration

Section 8

CODE DESCRIPTION

This section describes the code of COALR and includes the following topics:

- Hierarchy diagram
- Subroutine descriptions
- Logic flow diagrams
- Common blocks
- Files

8.1 HIERARCHY DIAGRAM

Figure 8-1 is a hierarchy diagram for COALR. The diagram indicates the calling hierarchy of subroutines and functions. The executive routine is COALR. Routine COALR calls subroutines below it that are connected to it by solid lines. These subroutines in turn may call other subroutines or functions further below, etc., down to three levels of subordination. On the diagram, rectangles are used for the executive routine, block data, and subroutines. Ovals are used for functions.

During a run COALR calls subroutines from left to right along the diagram. The subroutines called by COALR fall into the following four groups:

- The message routine
- Case run input routines
- The cost reformulation routine
- Financial analysis routines

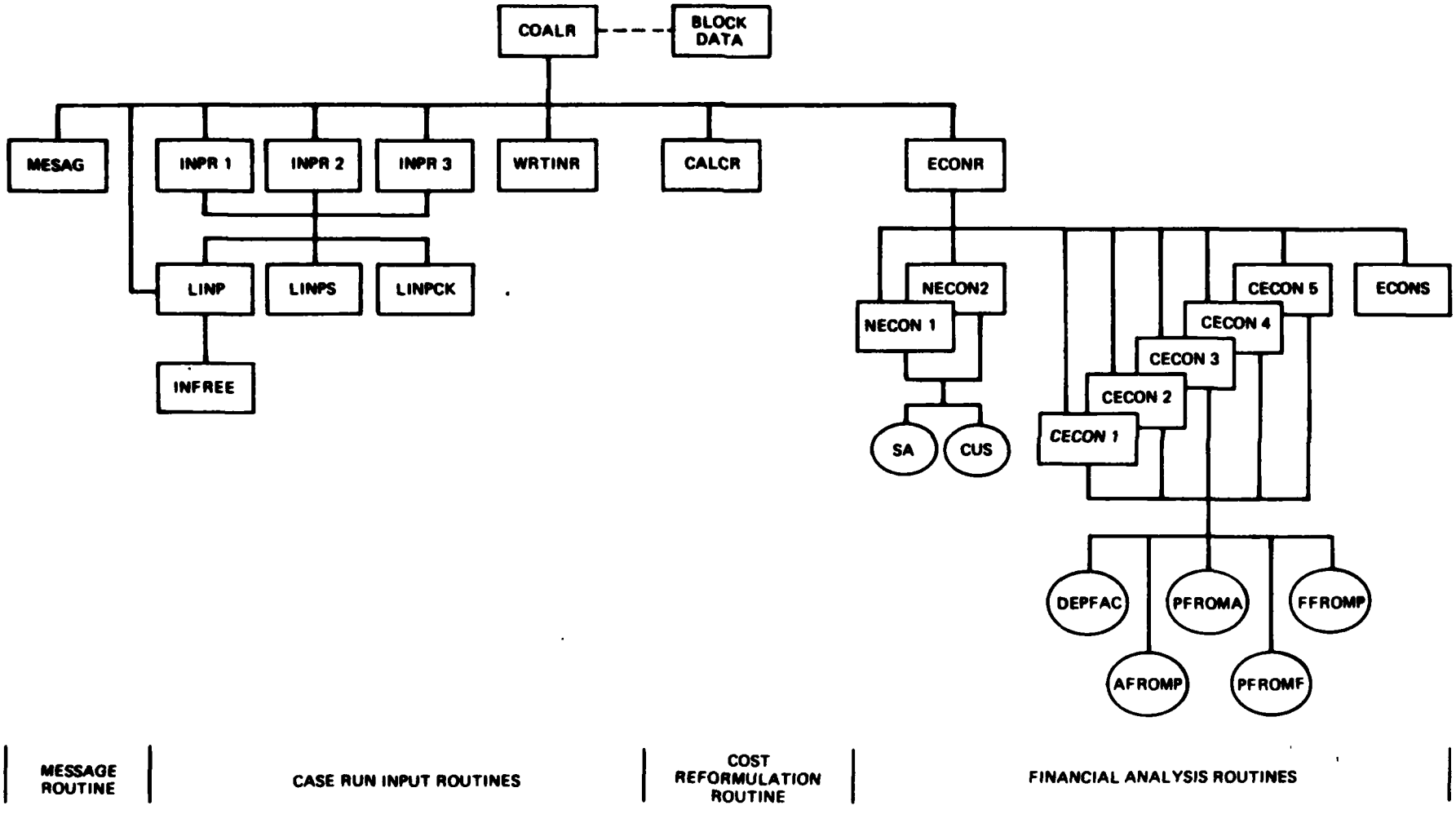


Figure 8-1 COALR HIERARCHY DIAGRAM

8.2 SUBROUTINE DESCRIPTIONS

The subroutines and functions in the program are described briefly below.

8.2.1 The Message Routine

MESAGR writes an identification block on the front page of each program run.

8.2.2 Case Run Input Routines

INPR1 reads plant, coal, and utility input data and stores it in internal variables. INPR2 reads economic data on schedule and Navy financial parameters. INPR3 reads reformulation data, comparison data, and commercial data. WRTINR writes the interpretive echo of the case input data.

Four utility routines assist input interpretation. LINP examines each new line of input to determine whether it is a section declaration. INFREE actually reads each new line character by character and separates words from numbers. LINPS compares input words with expected key words within each section of data. LINPCK checks whether a variable is numeric or alphanumeric.

8.2.3 The Cost Reformulation Routine

The cost reformulation routine CALCR converts the reformulation project costs into display year dollars.

8.2.4 Financial Analysis Routines

ECONR serves as an executive routine to manage calls to the financial routines. NECON1 calculates present values and levelized costs for a Navy financed/Navy operated venture. NECON2 calculates year-by-year costs and benefits for such an all-Navy venture. SA calculates the Navy discount factor for a one-time cash flow. CUS calculates the Navy cumulative uniform series discount factor for a series of annual cash flows.

Commercial economic calculations are carried out by 11 subroutines and functions. CECON1 calculates private venture minimum revenue requirements. CECON2 calculates private or third party investor cash flows during the construction period. CECON3 calculates third party investor cash flows during the operating period. CECON4 calculates private venture cash flows during the operating period. CECON5 calculates Navy cash flows during the operating period for a third party financed/Navy operated venture. ECONS prints summary reports.

Five utility functions assist the commercial economic calculations. DEPFAC calculates the fraction of capital depreciated each year. AFROMP calculates the factor to form an annuity from a present value. PFROMA calculates the factor to form a present value from an annuity. PFROMF calculates the factor to form a present value from a future value. FFROMP calculates the factor to form a future value from a present value.

8.3 LOGIC FLOW DIAGRAMS

This section provides logic flow diagrams for the financial calculations that were sumarized in Figure 1-3. Figure 1-3 showed that project costs are reformulated to display year dollars in subroutine CALCR, and then all financial calculations are made by or called from ECONR. Figures 8-2 through 8-8 (presented at the end of this section) provide logic flow diagrams for subroutines NECON1, NECON2, CECON2, CECON3, CECON5, CECON4, and CECON1, respectively.

8.4 COMMON BLOCKS

COALR has a number of blocks of common variables that are shared by program routines. Incidence Table 8-1 presented at the end of this section lists the common blocks and routines and indicates where they coincide.

8.5 FILES

COALR is composed of a number of files available to the user. These are stored on tape for use with Control Data Corporation's Western Cybernet Center's computer designated KWA in Sunnyvale, California. The COALR

files and their functions are listed in Table 8-2 at the end of this section. The read-only program tape containing these files is designated COLCONV, and is assigned to NCEL user number L6016GS. The files are retrieved from this tape by the procedures for running the programs which are described in Section 5. Users should contact the NCEL Data Processing Center if they desire to use the tape and files in a way other than specified in the procedures.

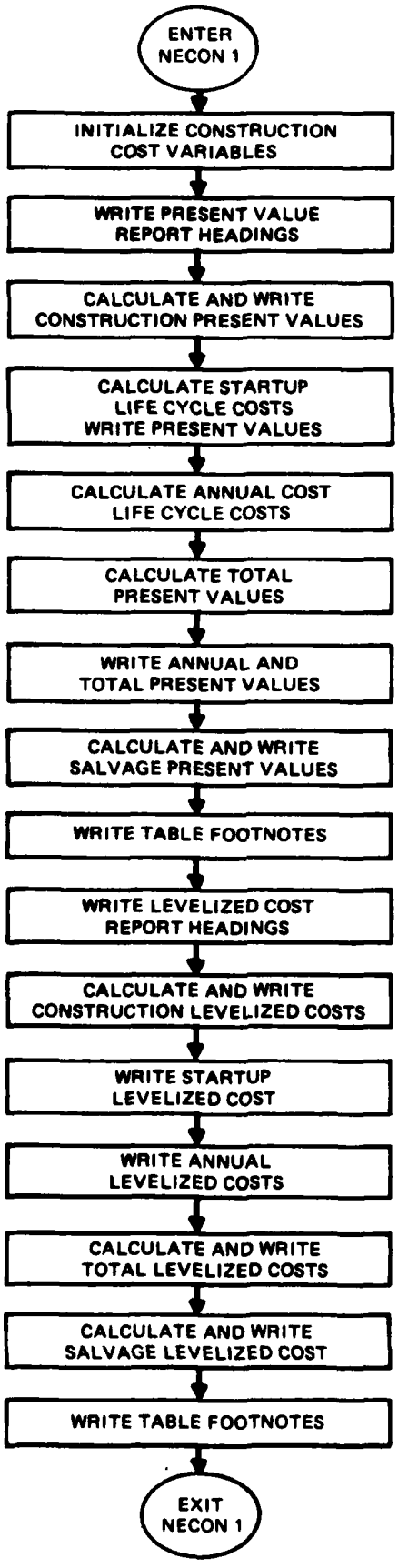


Figure 8-2 LOGIC FLOW DIAGRAM FOR SUBROUTINE NECON 1, CALCULATION OF NAVY PRESENT VALUES AND LEVELIZED COSTS (REPORTS 1,2,4 AND 5)

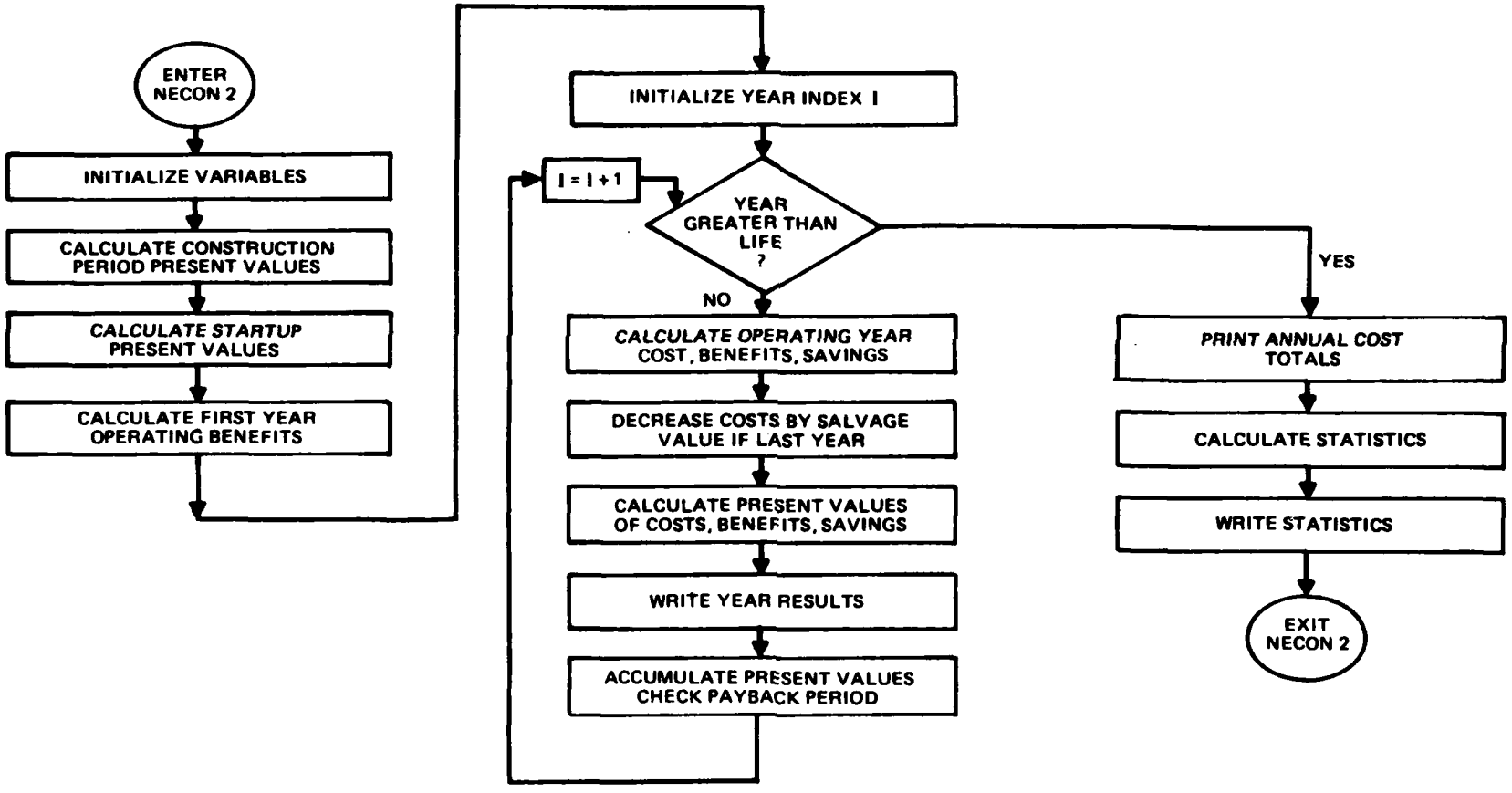


Figure 8-3 LOGIC FLOW DIAGRAM FOR SUBROUTINE NECON 2, CALCULATION OF NAVY COST AND BENEFIT ANALYSES (REPORT 3)

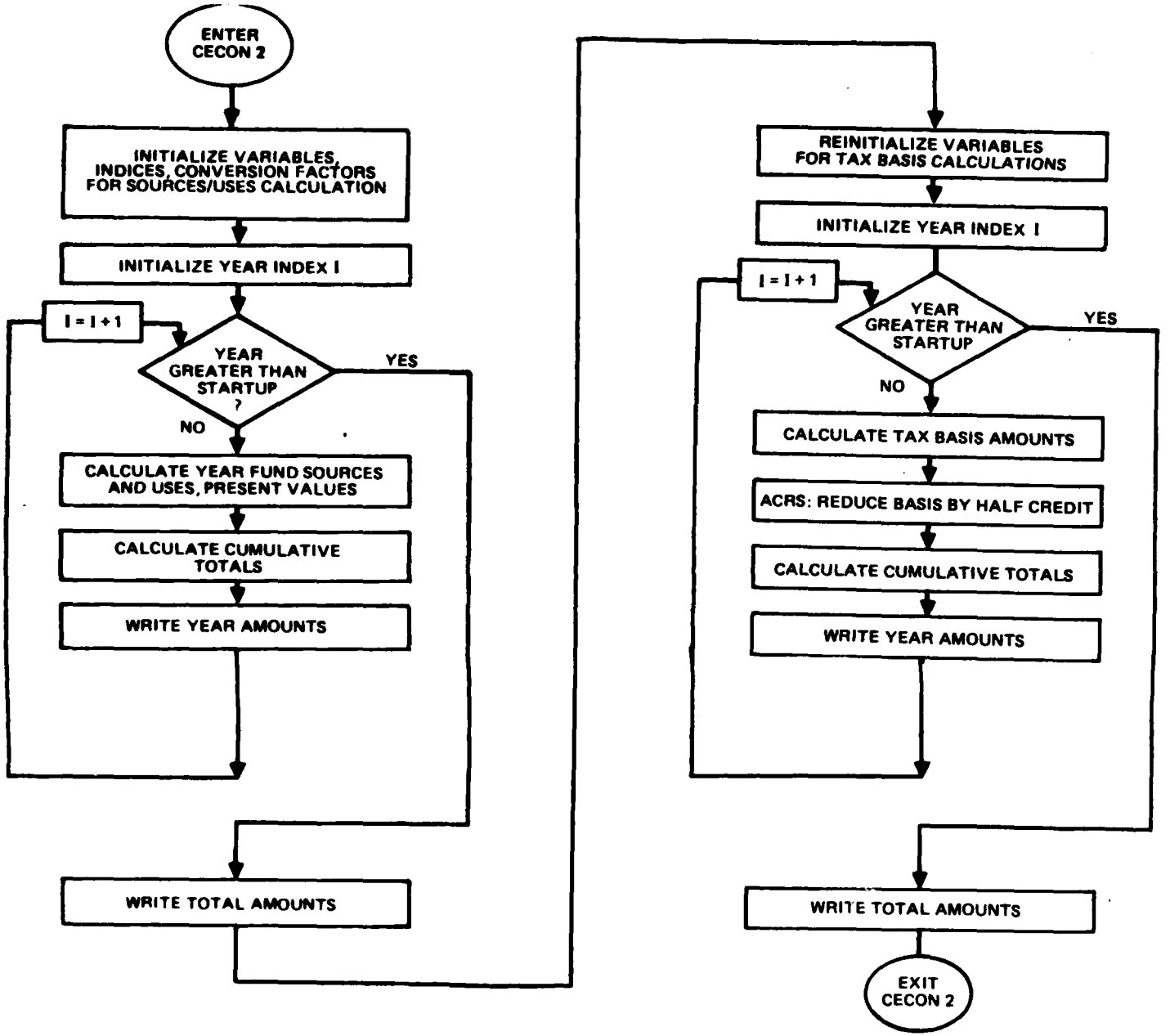


Figure 8-4 LOGIC FLOW DIAGRAM FOR SUBROUTINE CECON 2, CALCULATION OF INVESTOR FLOWS DURING CONSTRUCTION PERIOD (REPORTS 6 AND 9)

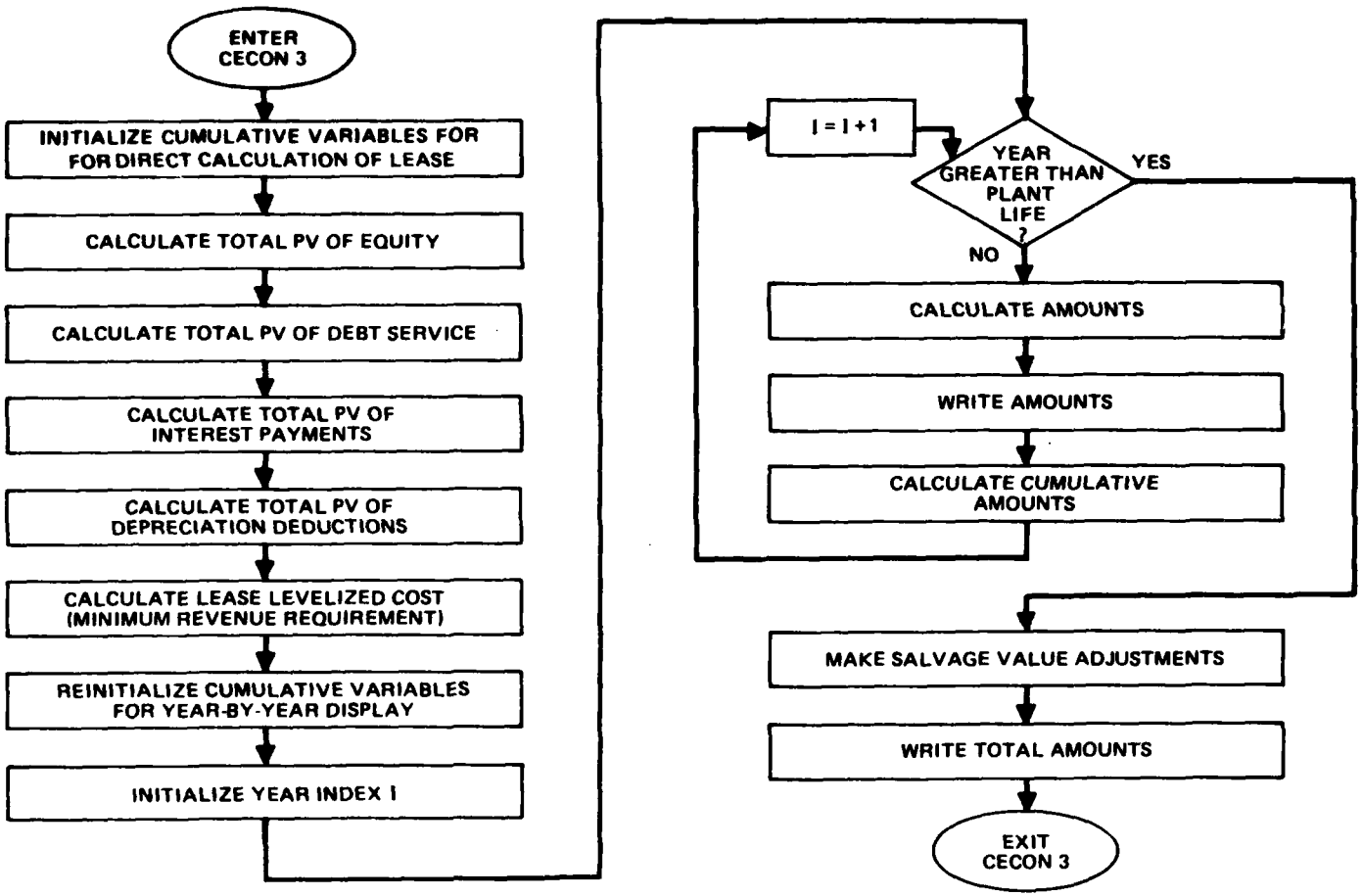


Figure 8-5 LOGIC FLOW DIAGRAM FOR SUBROUTINE CECON 3, CALCULATION OF THIRD PARTY INVESTOR CASH FLOWS DURING OPERATING PERIOD (REPORT 3)

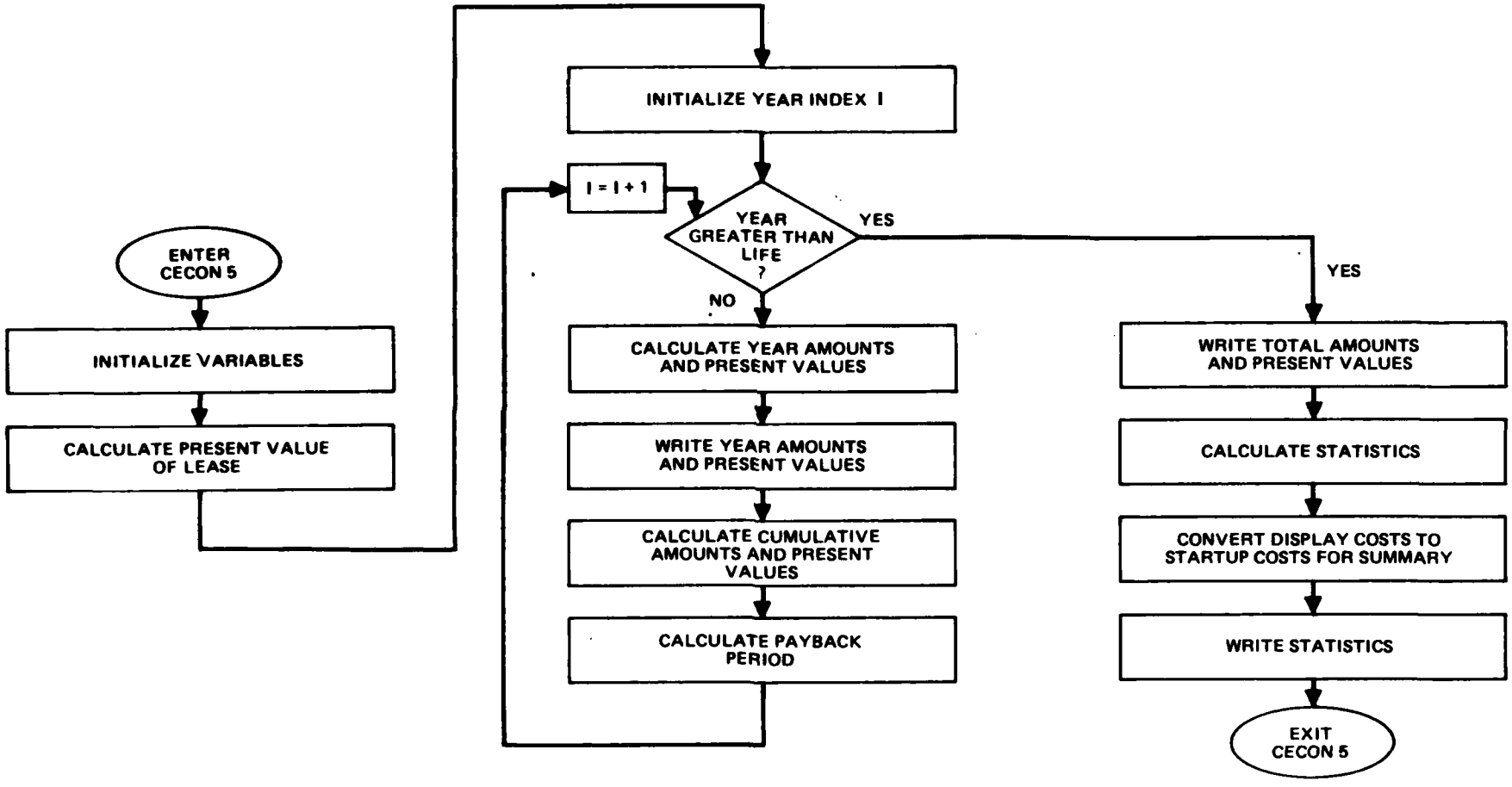


Figure 8-6 LOGIC FLOW DIAGRAM FOR SUBROUTINE CECON 5, CALCULATION OF NAVY CASH FLOWS DURING OPERATING PERIOD (REPORT 8)

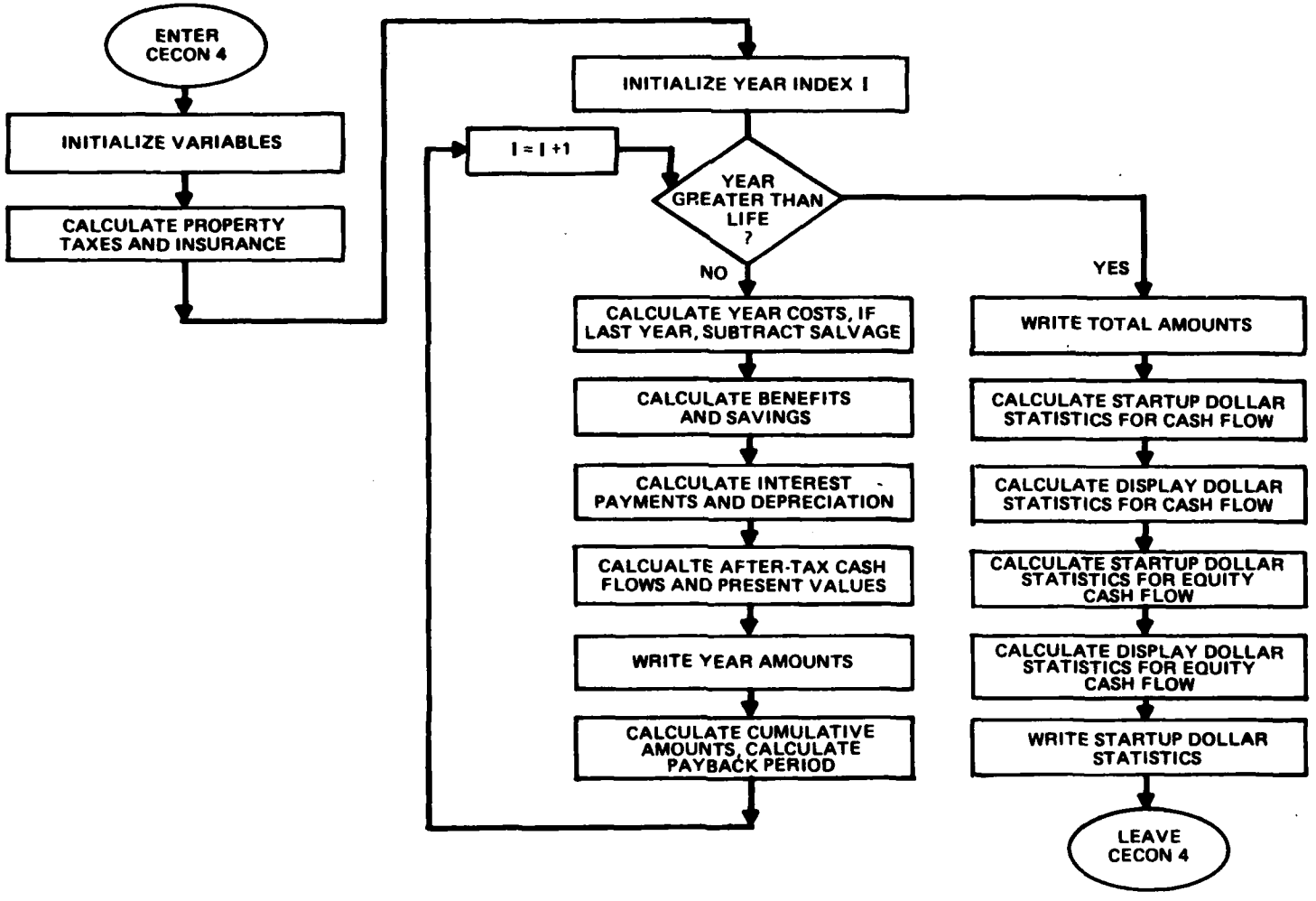


Figure 8-7 LOGIC FLOW DIAGRAM FOR SUBROUTINE CECON 4, CALCULATION OF PRIVATE VENTURE CASH FLOWS DURING OPERATING PERIOD (REPORT 10)

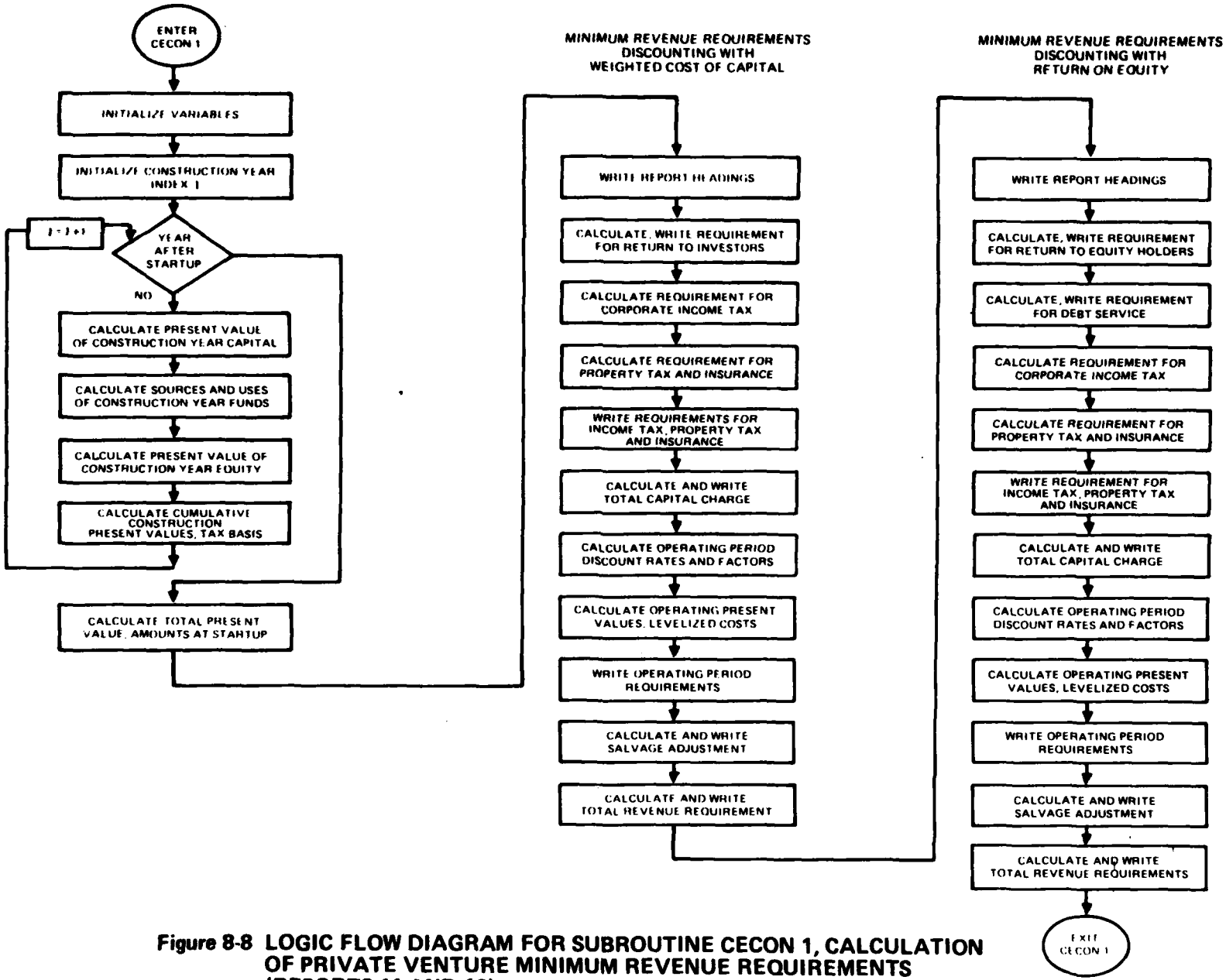


Figure 8-8 LOGIC FLOW DIAGRAM FOR SUBROUTINE CECON 1, CALCULATION OF PRIVATE VENTURE MINIMUM REVENUE REQUIREMENTS (REPORTS 11 AND 12)

Table 8-1

COALR COMMON BLOCK INCIDENCE TABLE

Routine	Common Block											
	BSECOM	COAL1	COAL2	COAL3	COAL4	ESTATS	INFCOM	LINPCM	SECTCM	SYSCDM	TTLCOM	WRDCOM
COALR		X	X	X	X		X	X	X	X	X	X
BLOCK DATA		X	X	X	X				X	X		
CALCR	X	X	X	X	X					X	X	
CECON1		X	X	X	X					X	X	
CECON2	X	X	X	X	X	X				X	X	
CECON3	X	X	X	X	X	X				X	X	
CECON4	X	X	X	X	X	X				X	X	
CECON5		X	X	X	X	X				X	X	
ECONR	X	X	X	X	X	X				X	X	
ECONS		X	X	X	X	X				X	X	
INFREE										X		X
INPR1		X	X	X	X		X	X	X	X	X	
INPR2		X	X	X	X		X	X	X	X	X	
INPR3		X	X	X	X		X	X	X	X	X	
LINP								X		X		X
LINPS								X		X		X
LINPCK								X		X		X
MESAGR										X		
NECON1		X	X	X	X					X	X	
NECON2	X	X	X	X	X	X				X	X	
WRTINR		X	X	X	X					X	X	

Table 8-2

NAMES AND FUNCTIONS OF COALR FILES ON TAPE COLCONV

File Name	File Functions
COALRR	Relocatable code
COALR	Source code
EXAMPLP	Sample case input

Section 9

USE OF COALR TO REPLICATE COMMERCIAL FINANCIAL ANALYSES

One of the objectives for the use of COALR is replication of coal-use project financial analyses appearing in proposals or reports to the Navy or appearing in the technical literature. The range of options and input variables provided in COALR should be sufficient to permit replication of the results of most coal-use project financial analyses prepared by others.

The difficulty of replicating a financial analysis by others will depend on the completeness of information provided on the financial input parameters used in the analysis. If all the input variables required by COALR are explicitly stated in the financial analysis, then replication should be accomplished in a straightforward manner by COALR in a single run.

If the input information is incomplete for a given financial analysis, then the user will have to determine the missing information by a trial and error procedure involving several runs of COALR. A rapidly converging trial and error procedure which the user may find convenient is the method of successive trials. This trial and error procedure is described in Appendix B.

REFERENCES

2-1 A Coal-Use Economics Methodology for Navy Bases, Bechtel Group, Inc., San Francisco, California, Draft NCEL Contract N62474-82-C-8290, Engineering Services for Coal Conversion Guidance, Phase I, July 1983.

2-2 Economic Analysis Handbook, P-442, Naval Facilities Engineering Command, 1975.

2-3 Slaminski, J. M., "Economic Analysis and Priority Rating Formulation for Navy Shore Facilities Energy R&D Projects," Civil Engineering Laboratory, Port Hueneme, California, November 1977.

2-4 Instruction for Preparation of Economic Analyses, LANTNAVFACENGCOM, 407:ARM, March 19, 1980.

2-5 Ward, Carter J., "Simplified Economic Analysis for Navy Shore Facilities Energy R&D Products," Civil Engineering Laboratory, Port Hueneme, California, December 11, 1979.

2-6 Grant, E. L., Ireson, W. G., and Leavenworth, R. S., Principles of Engineering Economy, Sixth Edition, John Wiley & Sons, New York, 1976, pp. 33-37.

2-7 Comparison of Coal Energy Conversion Technologies at Navy Bases, Bechtel Group, Inc., San Francisco, California, Draft NCEL Contract Report, Contract N62474-82-C-8290, Engineering Services for Coal Conversion Guidance, Phase III, July 1983.

3-1 Coal Conversion Cost Computer Program, Peter F. Loftus Corporation, Pittsburgh, Pennsylvania, Draft NCEL Contract Report, Contract N62474-81-C-9409, September 1982.

7-1 Economic Analysis Handbook, p-422, Naval Facilities Engineering Command, 1975.

Appendix A

COALR OUTPUTS GENERATED BY RUN WITH INPUT FILE EXAMPLR

This appendix contains four case outputs generated by a run with input file EXAMPLR. The case outputs, Tables A-1 through A-4, demonstrate all major program options, as described in Section 7.

The same project capital costs, first year operating and maintenance costs, and life cycle schedule are included in all four cases. The four cases differ only in the choices made by the user for the venture structure, the depreciation calculation method, and the comparison fuel. Since all the output deal with the same project, several reports for Cases 2, 3, and 4 are identical with those for Case 1. Accordingly, the Case 1 output is reproduced in full in Table A-1. However, in Tables A-2, A-3, and A-4, for Cases 2 through 4, only those pages are included that differ from the corresponding pages for Case 1.

Table A-1

CASE 1 - THIRD PARTY FINANCED/NAVY OPERATED VENTURE,
ACRS DEPRECIATION, COMPARISON WITH BURNING OIL

INPUT DATA LISTING

```
*    EXAMPLE CASE 1
*
PLANT DATA
PEAK LOAD 200.    LOAD FACTOR .50
*
COAL DATA
PRICE 53.80    DIR 5.
*
UTILITY DATA
OIL 1.0876    DIR 8.
GAS 4.62    DIR 10.
ELECTRIC .06042    DIR 6.
STEAM 10.3    DIR 6.
MANHOURS 30.
*
ECONOMIC DATA
STARTUP YEAR 1987  MONTH 11
DISPLAY YEAR 1982  MONTH 11
COST INDEX 315.0
SCHEDULE 63.0 37.0
LIFE 25.  SALVAGE 0.    DISCOUNT 10.
*
REFORMULATION DATA
CONSTRUCTION 14950    INDEX 216.8
STARTUP 1640    INDEX 216.8
COAL 1540    RATE 30. * $/T
ELECTRIC 140    RATE .033 * $/KWH
GAS 10    RATE  2.37 * $/1000-SCF
OIL 10    RATE .4734 * $/GAL
STEAM 10    RATE 6.00 * $/1000-LB
LABOR 1135    RATE 20. * $/HR
OTHER ANNUAL 800    INDEX 216.8
*
COMPARISON DATA
BURN OIL
*
COMMERCIAL DATA
INFLATION 6.0
DEBT 30    INTEREST 11.    RETURN 18.
THIRD PARTY  LEASE LIFE 15.
INCOME TAX RATE 50. CREDIT 10
PROPERTY TAX PERCENT 2.
DEPRECIATION ACRS LIFE 5
*
END CASE
```

COALR V1.0

EXAMPLR CASE 1

PLANT DATA

PEAK LOAD (1000-LB/HR)	LOAD FACTOR
200.00	.50

COAL DATA

PRICE (DISPLAY YEAR $/TON)	DIFFERENTIAL INFLATION RATE (PERCENT/YEAR)
53.8	5.00

UTILITY DATA

	RATE (DISPLAY YEAR DOLLARS)		DIFFERENTIAL INFLATION RATE (PERCENT/YEAR)
ELECTRIC	$ .0604	/KWH	6.00
MANHOURS	$ 30.0000	/HOUR	
GAS	$ 4.6200	/1000-CU FT	10.00
STEAM	$ 10.3000	/1000-LBS	0.00
OIL	$ 1.0876	/GALLON	8.00

EXAMPLE CASE 1

ECONOMIC DATA

DISPLAY DATE - NOVEMBER 1982

STARTUP DATE - NOVEMBER 1987

SCHEDULE (PERCENT) - 63.00 37.00

DISPLAY YEAR COST INDEX - 315.00

PLANT LIFE (YEARS)	SALVAGE VALUE (1000 REFORMULATION DOLLARS)	NAVY DISCOUNT RATE (PERCENT/YEAR)
25.0	0.	10.00

COMMERCIAL DATA: THIRD PARTY FINANCING

INFLATION RATE:	6.00 PERCENT PER YEAR
DEBT FRACTION:	30.00 PERCENT
INTEREST RATE:	11.00 PERCENT PER YEAR
RETURN ON EQUITY:	18.00 PERCENT PER YEAR
INCOME TAX RATE:	50.00 PERCENT
TAX CREDIT:	10.00 PERCENT
PROPERTY TAX AND INS.:	2.00 PERCENT OF TOTAL CAPITAL REQUIREMENT
ACRS DEPRECIATION LIFE:	5 YEARS
LEASE LIFE:	15 YEARS

COALH V1.0 EXAMPLH CASE 1

REFORMULATION DATA

CUST ITEM	CUST(1000 $)	CUST ADJUSTMENT DENOMINATOR
TOTAL CONSTRUCTION	14950.	216.80 (COST INDEX)
STARTUP	1640.	216.80 (COST INDEX)
COAL	1540.	$ 30.00 / TON
ELECTRIC	140.	$ .03300 / KWH
GAS	10.	$ 2.37 / THOUSAND CUBIC FEET
OIL	10.	$ .4734 / THOUSAND GALLONS
STEAM	10.	$ 6.00 / THOUSAND POUNDS
LABOR	1135.	$ 20.00 / HOUR
OTHER ANNUAL	800.	216.80 (COST INDEX)

BASE CASE IS OIL-FIRED STEAM PLANT

COALR V1.0 EXAMPLE CASE 1

NAVY PRESENT VALUES IN DISPLAY YEAR DOLLARS *

		COST (1000 $)	DISCOUNT FACTOR	PRESENT VALUE (1000 $)	UNIT PRESENT VALUE ** ($/MILLION BTU)
CONSTRUCTION	1986	8037.	.7166	5759.	.26
CONSTRUCTION	1987	13685.	.6515	8915.	.41
TOTAL CONSTRUCTION		21722.		14675.	.67
STARTUP	1987	2383.	.6515	1552.	.07
1987 - 2012					
LABOR		1703.	5.9135	10069.	.46
OPERATING + MAINTENANCE MATERIAL		1162.	5.9135	6874.	.31
ELECTRICITY		256.	13.5466	3472.	.16
GAS		19.	25.0000	487.	.02
STEAM		17.	13.5466	231.	.01
OIL		23.	18.2930	420.	.02
COAL		2762.	11.7108	32347.	1.49
TOTAL				70123.	3.20

* ALL COSTS AND PRESENT VALUES ARE REFERENCED TO THE DISPLAY DATE OF NOVEMBER 1982

** 21900. BILLION BTUS OF HEAT ARE TRANSFERRED IN 25.0 YEARS OF OPERATING LIFE

COALR V1.0 EXAMPLR CASE 1

NAVY LEVELIZED COSTS IN DISPLAY YEAR DOLLARS *

		COST (1000 $)	LEVELIZING FACTOR	LEVELIZED COST (1000 $)	UNIT LEVELIZED COST ** $/MILLION BTU
CONSTRUCTION	1986	8037.	.1212	974.	1.11
CONSTRUCTION	1987	13685.	.1102	1509.	1.72
TOTAL CONSTRUCTION		21722.		2483.	2.83
STARTUP	1987	2383.	.1102	263.	.30
1987 - 2012					
LABOR		1703.	1.0000	1703.	1.94
OPERATING + MAINTENANCE MATERIAL		1162.	1.0000	1162.	1.33
ELECTRICITY		256.	2.2908	587.	.67
GAS		19.	4.2276	82.	.09
STEAM		17.	2.2908	39.	.04
OIL		23.	3.0935	71.	.08
COAL		2762.	1.9809	5469.	6.24
TOTAL				11859.	13.54

* ALL COSTS ARE REFERENCED TO THE DISPLAY DATE OF NOVEMBER 1982

** 876.00 BILLION BTUS OF HEAT ARE TRANSFERRED ANNUALLY

COALR V1.0 EXAMPLE CASE 1

NAVY COST AND BENEFIT ANALYSIS
(THOUSANDS OF DISPLAY YEAR DOLLARS)

YEAR	CONSTRUCT COSTS	STARTUP COST	OPERATING COSTS	OPERATING BENEFITS	SAVINGS (OPERATING BENEFITS -COSTS)	PRESENT VALUE DISCOUNT FACTOR	PV* OF CONSTRUCT + STARTUP COSTS	PV OF OPERATING COSTS	PV OF SAVINGS
1986	8037.					.717	5759.		
1987	13085.	2383.				.651	10468.		
1988			6921.	13163.	6242.	.592		4099.	3697.
1989			7130.	14150.	7020.	.538		3834.	3780.
1990			7351.	15216.	7866.	.489		3598.	3850.
1991			7582.	16388.	8785.	.445		3374.	3909.
1992			7826.	17610.	9784.	.405		3166.	3958.
1993			8083.	18953.	10870.	.368		2972.	3997.
1994			8353.	20402.	12049.	.334		2792.	4028.
1995			8637.	21967.	13329.	.304		2625.	4051.
1996			8937.	23656.	14720.	.276		2469.	4067.
1997			9252.	25481.	16229.	.251		2324.	4076.
1998			9583.	27451.	17868.	.228		2188.	4080.
1999			9933.	29578.	19646.	.208		2062.	4078.
2000			10300.	31875.	21575.	.189		1944.	4071.
2001			10687.	34356.	23668.	.172		1833.	4060.
2002			11095.	37034.	25939.	.156		1730.	4045.
2003			11524.	39926.	28402.	.142		1634.	4027.
2004			11977.	43050.	31073.	.129		1544.	4005.
2005			12453.	46422.	33969.	.117		1459.	3980.
2006			12955.	50063.	37109.	.107		1380.	3953.
2007			13483.	53996.	40512.	.097		1306.	3923.
2008			14040.	58242.	44202.	.088		1236.	3891.
2009			14627.	62827.	48200.	.080		1171.	3858.
2010			15246.	67779.	52533.	.073		1109.	3822.
2011			15897.	73125.	57228.	.066		1051.	3785.
2012			16584.	78899.	62315.	.060		997.	3747.
TOTAL	21722.	2383.	270497.	921590.	651133.		16227.	93903.	98739.

PRESENT VALUE OF COSTS = $ 70130. THOUSAND
UNIT PRESENT VALUE = $ 3.20 PER MILLION BTU (PV / 21900. BILLION BTU)
LEVELIZED COST = $ 11859. THOUSAND (PV * .1691)
UNIT LEVELIZED COST = $ 13.54 PER MILLION BTU (LEVELIZED COST / 876. BILLION BTU)
SAVINGS/INVESTMENT RATIO = 6.08 (PV SAVINGS / PV INVESTMENT)
DISCOUNTED PAYBACK PERIOD = 9.3 YEARS (NO. OF YEARS NEEDED FOR CUMULATIVE PV SAVINGS = PV INVESTMENT)

* PV DENOTES PRESENT VALUE

COALR V1.0 EXAMPLR CASE 1

NAVY PRESENT VALUES IN STARTUP YEAR DOLLARS *

		COST (1000 $)	DISCOUNT FACTOR	PRESENT VALUE (1000 $)	UNIT PRESENT VALUE ** ($/MILLION BTU)
CONSTRUCTION	1986	10755.	1.1541	12413.	.57
CONSTRUCTION	1987	18313.	1.0492	19214.	.88
TOTAL CONSTRUCTION		29068.		31627.	1.44
STARTUP	1987	3189.	1.0492	3344.	.15
1987 - 2012					
LABOR		2278.	9.5237	21699.	.99
OPERATING + MAINTENANCE MATERIAL		1556.	9.5237	14814.	.68
ELECTRICITY		459.	16.3028	7484.	.34
GAS		42.	25.0000	1059.	.05
STEAM		31.	16.3028	501.	.02
OIL		45.	20.0507	904.	.04
COAL		4717.	14.7776	69704.	3.18
TOTAL				151131.	6.90

* ALL COSTS AND PRESENT VALUES ARE REFERENCED TO THE STARTUP DATE OF NOVEMBER 1987

** 21900. BILLION BTUS OF HEAT ARE TRANSFERRED IN 25.0 YEARS OF OPERATING LIFE

COALR V1.0 EXAMPLE CASE 1

NAVY LEVELIZED COSTS IN STARTUP YEAR DOLLARS *

		COST (1000 $)	LEVELIZING FACTOR	LEVELIZED COST (1000 $)	UNIT LEVELIZED COST ** $/MILLION BTU
CONSTRUCTION	1986	10755.	.1212	1303.	1.49
CONSTRUCTION	1987	18313.	.1102	2019.	2.30
TOTAL CONSTRUCTION		29068.		3321.	3.79
STARTUP	1987	3189.	.1102	351.	.40
1987 - 2012					
LABOR		2278.	1.0000	2279.	2.60
OPERATING + MAINTENANCE MATERIAL		1556.	1.0000	1554.	1.78
ELECTRICITY		459.	1.7118	784.	.90
GAS		42.	2.6250	110.	.13
STEAM		31.	1.7118	53.	.06
OIL		45.	2.1054	95.	.11
COAL		4117.	1.9517	7319.	8.36
TOTAL				15869.	18.12

* ALL COSTS ARE REFERENCED TO THE STARTUP DATE OF NOVEMBER 1987

** 876.00 BILLION BTUS OF HEAT ARE TRANSFERRED ANNUALLY

COALR V1.0 EXAMPLR CASE 1

THIRD PARTY FINANCED/NAVY OPERATED VENTURE:
INVESTOR CASH FLOWS DURING CONSTRUCTION PERIOD
(THOUSANDS OF DOLLARS)

YEAR	SOURCE OF FUNDS: DEBT	SOURCE OF FUNDS: EQUITY	USE OF FUNDS: CAPITAL COST	USE OF FUNDS: INTEREST ON DEBT	TOTAL SOURCES AND USES	TAX SAVINGS FROM IDC DEDUCTION	TAX CREDITS	AFTER TAX EQUITY CASH FLOW	PRESENT VALUE: EQUITY** PORTION	PRESENT VALUE: TOTAL* INVESTMENT
1986	3044.	7103.	10147.	0.	10147.	0.	1015.	6088.	7184.	10563.
1987	6551.	15286.	21502.	335.	21837.	167.	1959.	13159.	13159.	19376.
TOTAL	9595.	22388.	31648.	335.	31983.	167.	2974.	19247.	20343.	29938.

* PRESENT VALUE AT STARTUP BASED ON RETURN ON EQUITY = 18.00 PERCENT PER YEAR

** PRESENT VALUE AT STARTUP BASED ON WEIGHTED COST OF CAPITAL = 15.90 PERCENT PER YEAR

CALCULATION OF TAX BASIS
(THOUSANDS OF DOLLARS)

YEAR	PLANT INVESTMENT (INCLUDING STARTUP): DEPRECIABLE PORTION	PLANT INVESTMENT (INCLUDING STARTUP): TOTAL	INTEREST ON DEBT	TAX CREDIT ADJUSTMENT TO TAX BASIS	TAX BASIS
1986	10147.	10147.	0.	507.	9639.
1987	19589.	21502.	335.	979.	18944.
TOTAL	29735.	31648.	335.	1487.	28583.

COALR V1.0 EXAMPLE CASE 1

THIRD PARTY FINANCED/NAVY OPERATED VENTURE:
INVESTOR CASH FLOWS DURING OPERATING PERIOD
(THOUSANDS OF DOLLARS)

YEAR	LEVELIZED MINIMUM REVENUE REQUIREMENT	DEBT SERVICE		BEFORE-TAX EQUITY CASH FLOW	DEPRECIATION	TAXABLE INCOME	TAXES	AFTER-TAX EQUITY CASH FLOW	PRESENT VALUE (PV) AT STARTUP RDE = 18.00 PCT	
		INTEREST PORTION	TOTAL						FACTOR	AMOUNT
1988	6354.	1055.	1334.	5019.	4287.	1011.	505.	4514.	.847	3825.
1989	6354.	1025.	1334.	5019.	6268.	-960.	-480.	5499.	.718	3949.
1990	6354.	991.	1334.	5019.	6002.	-640.	-320.	5339.	.609	3250.
1991	6354.	953.	1334.	5019.	6002.	-602.	-301.	5320.	.516	2744.
1992	6354.	911.	1334.	5019.	6002.	-560.	-280.	5299.	.437	2316.
1993	6354.	864.	1334.	5019.	0.	5489.	2745.	2275.	.370	843.
1994	6354.	813.	1334.	5019.	0.	5541.	2770.	2249.	.314	706.
1995	6354.	755.	1334.	5019.	0.	5598.	2799.	2220.	.266	591.
1996	6354.	692.	1334.	5019.	0.	5662.	2831.	2188.	.225	493.
1997	6354.	621.	1334.	5019.	0.	5733.	2866.	2153.	.191	411.
1998	6354.	542.	1334.	5019.	0.	5811.	2906.	2114.	.162	342.
1999	6354.	455.	1334.	5019.	0.	5898.	2949.	2070.	.137	284.
2000	6354.	359.	1334.	5019.	0.	5995.	2997.	2022.	.116	235.
2001	6354.	251.	1334.	5019.	0.	6102.	3051.	1968.	.099	194.
2002	6354.	132.	1334.	5019.	0.	6221.	3111.	1909.	.084	159.
TOTAL	95303.	10420.	20015.	75288.	28543.	56300.	28150.	47138.		20343.

COALK V1.0 EXAMPLR CASE 1

THIRD PARTY FINANCED/NAVY OPERATED VENTURE:
NAVY CASH FLOWS DURING OPERATING PERIOD
(THOUSANDS OF DOLLARS)

YEAR	LEASE COST CURRENT DOLLARS	LEASE COST CONSTANT DOLLARS	PV* FACTOR FOR LEASE	PV OF LEASE COST	OPERATING COSTS	OPERATING BENEFITS	SAVINGS (OPER. BENEFITS - COSTS)	PV FACTOR FOR SAVINGS AND OPERATING COSTS	PV OF OPERATING COSTS	PV OF SAVINGS
1988	6354.	4479.	.564	2528.	6921.	13163.	6242.	.592	4099.	3697.
1989	6354.	4225.	.513	2168.	7130.	14150.	7020.	.538	3839.	3780.
1990	6354.	3986.	.467	1860.	7351.	15216.	7866.	.489	3598.	3850.
1991	6354.	3761.	.424	1595.	7582.	16368.	8795.	.445	3374.	3909.
1992	6354.	3548.	.386	1368.	7826.	17610.	9784.	.405	3166.	3958.
1993	6354.	3347.	.350	1173.	8083.	18953.	10870.	.368	2972.	3997.
1994	6354.	3158.	.319	1006.	8351.	20402.	12049.	.334	2792.	4028.
1995	6354.	2979.	.290	863.	8637.	21967.	13329.	.304	2625.	4051.
1996	6354.	2810.	.263	740.	8937.	23656.	14720.	.276	2469.	4067.
1997	6354.	2651.	.239	635.	9252.	25481.	16229.	.251	2324.	4076.
1998	6354.	2501.	.218	544.	9583.	27451.	17868.	.228	2188.	4080.
1999	6354.	2359.	.198	467.	9933.	29578.	19646.	.208	2062.	4078.
2000	6354.	2226.	.180	400.	10300.	31875.	21575.	.189	1944.	4071.
2001	6354.	2100.	.164	343.	10687.	34356.	23668.	.172	1833.	4060.
2002	6354.	1981.	.149	294.	11095.	37034.	25939.	.156	1730.	4045.
2003	0.	0.	.135	0.	11524.	39926.	28402.	.142	1634.	4027.
2004	0.	0.	.123	0.	11977.	43050.	31073.	.129	1544.	4005.
2005	0.	0.	.112	0.	12453.	46422.	33969.	.117	1459.	3980.
2006	0.	0.	.102	0.	12955.	50063.	37109.	.107	1380.	3953.
2007	0.	0.	.092	0.	13483.	53996.	40512.	.097	1306.	3923.
2008	0.	0.	.084	0.	14040.	58242.	44202.	.088	1236.	3891.
2009	0.	0.	.076	0.	14627.	62827.	48200.	.080	1171.	3858.
2010	0.	0.	.069	0.	15246.	67779.	52533.	.073	1109.	3822.
2011	0.	0.	.063	0.	15897.	73125.	57228.	.066	1051.	3785.
2012	0.	0.	.057	0.	16584.	78899.	62315.	.060	997.	3747.
TOTAL	95303.	46111.		15985.	270457.	921590.	651133.		53903.	98739.

PRESENT VALUE OF COSTS = $ 69888. THOUSAND (LEASE PLUS OPERATING COSTS)
UNIT PRESENT VALUE = $ 3.19 PER MILLION BTU (PV / 21900. BILLION BTU)
LEVELIZED COST = $ 11818. THOUSAND (PV * .1691
UNIT LEVELIZED COST = $ 13.49 PER MILLION BTU (LEVELIZED COST / 876. BILLION BTU)
SAVINGS/INVESTMENT RATIO = 6.18 (PV SAVINGS / PV LEASE)
DISCOUNTED PAYBACK PERIOD = 4.2 YEARS (NO. OF YEARS NEEDED FOR CUMULATIVE PV SAVINGS = TOTAL PV LEASE)

* PV DENOTES PRESENT VALUE.
** PRESENT VALUES ARE REFERENCED TO THE DISPLAY YEAR.
*** LEVELIZED COSTS ARE IN CONSTANT DISPLAY YEAR DOLLARS.

COALR V1.0 EXAMPLR CASE 1

SUMMARY:

NAVY FINANCED/NAVY UPERATED VENTURE VS. THIRD PARTY FINANCED/NAVY UPERATED VENTURE

	PRESENT VALUE REFERENCED TO DISPLAY YEAR (11/1982)	PRESENT VALUE REFERENCED TO STARTUP YEAR (11/1987)
NAVY FINANCED/NAVY OPERATED VENTURE:		
PRESENT VALUE	$ 70130. THOUSAND	$151145. THOUSAND
UNIT PRESENT VALUE	$ 3.20 PER MILLION BTU	$ 6.90 PER MILLION BTU
LEVELIZED COST	$ 11859. THOUSAND	$ 15973. THOUSAND
UNIT LEVELIZED COST	$ 13.54 PER MILLION BTU	$ 18.12 PER MILLION BTU
SAVINGS/INVESTMENT RATIO	6.08	
DISCOUNTED PAYBACK PERIOD	4.3 YEARS	
THIRD PARTY FINANCED/NAVY UPERATED VENTURE:		
NAVY OPERATOR		
PRESENT VALUE	$ 69888. THOUSAND	$150624. THOUSAND
UNIT PRESENT VALUE	$ 3.19 PER MILLION BTU	$ 6.88 PER MILLION BTU
LEVELIZED COST	$ 11818. THOUSAND	$ 15915. THOUSAND
UNIT LEVELIZED COST	$ 13.49 PER MILLION BTU	$ 18.05 PER MILLION BTU
SAVINGS/INVESTMENT RATIO	6.18	
DISCOUNTED PAYBACK PERIOD	4.2 YEARS	
PRIVATE INVESTOR		
LEVELIZED REVENUE (LEASE)	$ 6354. THOUSAND PER YEAR	
LEASE LIFE	15 YEARS	

Table A-2

CASE 2 - THIRD PARTY FINANCED/THIRD PARTY OPERATED (ALL PRIVATE) VENTURE, ACRS DEPRECIATION, COMPARISON WITH BURNING OIL

INPUT DATA LISTING

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*    EXAMPLE CASE 2
*
PLANT DATA
PEAK LOAD 200.   LOAD FACTOR .50
*
COAL DATA
PRICE 53.80   DIR 5.
*
UTILITY DATA
OIL 1.0876   DIR 8.
GAS 4.62   DIR 10.
ELECTRIC .06042   DIR 6.
STEAM 10.3   DIR 6.
MANHOURS 30.
*
ECONOMIC DATA
STARTUP YEAR 1987  MONTH 11
DISPLAY YEAR 1982  MONTH 11
COST INDEX 315.0
SCHEDULE 63.0 37.0
LIFE 25.  SALVAGE 0.   DISCOUNT 10.
*
REFORMULATION DATA
CONSTRUCTION 14950   INDEX 216.8
STARTUP 1640   INDEX 216.8
COAL 1540   RATE 30. * $/T
ELECTRIC 140   RATE .033 * $/KWH
GAS 10   RATE 2.37 * $/1000-SCF
OIL 10   RATE .4734 * $/GAL
STEAM 10   RATE 6.00 * $/1000-LB
LABOR 1135   RATE 20. * $/HR
OTHER ANNUAL 800   INDEX 216.8
*
COMPARISON DATA
BURN OIL
*
COMMERCIAL DATA
INFLATION 6.0
DEBT 30   INTEREST 11.   RETURN 16.
PRIVATE
INCOME TAX RATE 50. CREDIT 10
PROPERTY TAX PERCENT 2.
DEPRECIATION ACRS LIFE 5
*
END CASE
```

ECONOMIC DATA

DISPLAY DATE - NOVEMBER 1982

STARTUP DATE - NOVEMBER 1987

SCHEDULE (PERCENT) - 63.00 37.00

DISPLAY YEAR COST INDEX - 315.00

PLANT LIFE (YEARS)	SALVAGE VALUE (1000 REFORMULATION DOLLARS)	NAVY DISCOUNT RATE (PERCENT/YEAR)
25.0	0.	10.00

COMMERCIAL DATA: PRIVATE VENTURE

INFLATION RATE:	6.00	PERCENT PER YEAR
DEBT FRACTION:	30.00	PERCENT
INTEREST RATE:	11.00	PERCENT PER YEAR
RETURN ON EQUITY:	18.00	PERCENT PER YEAR
INCOME TAX RATE:	50.00	PERCENT
TAX CREDIT:	10.00	PERCENT
PROPERTY TAX AND INS.:	2.00	PERCENT OF TOTAL CAPITAL REQUIREMENT
ACRS DEPRECIATION LIFE:	5	YEARS

CUALR V1.0 EXAMPLR CASE 2

PRIVATE VENTURE CASH FLOWS DURING CONSTRUCTION PERIOD
(THOUSANDS OF DOLLARS)

	SOURCE OF FUNDS		USE OF FUNDS		TOTAL SOURCES AND USES	TAX SAVINGS FROM IDC DEDUCTION	TAX CREDITS	AFTER TAX EQUITY CASH FLOW	PRESENT VALUE	
YEAR	DEBT	EQUITY	CAPITAL COST	INTEREST ON DEBT					EQUITY** PORTION	TOTAL* INVESTMENT
1986	3044.	7103.	10147.	0.	10147.	0.	1015.	6088.	7184.	10563.
1987	6551.	15286.	21502.	335.	21837.	167.	1959.	13159.	13159.	19376.
TOTAL	9595.	22388.	31648.	335.	31983.	167.	2974.	19247.	20343.	29938.

* PRESENT VALUE AT STARTUP BASED ON RETURN ON EQUITY = 18.00 PERCENT PER YEAR

** PRESENT VALUE AT STARTUP BASED ON WEIGHTED COST OF CAPITAL = 15.90 PERCENT PER YEAR

CALCULATION OF TAX BASIS
(THOUSANDS OF DOLLARS)

	PLANT INVESTMENT (INCLUDING STARTUP)			TAX CREDIT ADJUSTMENT	
YEAR	DEPRECIABLE PORTION	TOTAL	INTEREST ON DEBT	TO TAX BASIS	TAX BASIS
1986	10147.	10147.	0.	507.	9639.
1987	19589.	21502.	335.	979.	18944.
TOTAL	29735.	31648.	335.	1487.	28583.

COALH V1.0 EXAMPLH CASE 2

PRIVATE VENTURE CASH FLOWS DURING OPERATING PERIOD
(THOUSANDS OF DOLLARS)

	CURRENT DOLLARS							PRESENT VALUE USING WEIGHTED COST OF CAPITAL *			PRESENT VALUE USING RETURN ON EQUITY **		
YEAR	OPERATING EXPENSES	OPERATING BENEFITS	OPERATING SAVINGS	INTEREST	TAX DEPRECIATION	AFTER-TAX NET CASH FLOW	AFTER-TAX EQUITY CASH FLOW	EXPENSES	INTEREST + TAX DEPRECIATION	AFTER-TAX NET CASH FLOW	EXPENSES + DEBT SERVICE	INTEREST + TAX DEPRECIATION	AFTER-TAX EQUITY CASH FLOW
1988	10564.	19363.	8800.	1055.	4287.	7071.	5932.	9114.	4610.	5101.	9918.	4528.	5027.
1989	11484.	22068.	10584.	1040.	6288.	8959.	7820.	8549.	5460.	5670.	9066.	5268.	5616.
1990	12498.	25158.	12661.	1038.	6002.	9850.	8710.	9027.	4521.	5327.	8300.	4284.	5301.
1991	13613.	28689.	15076.	1025.	6002.	11052.	9912.	7544.	3894.	5125.	7609.	3624.	5113.
1992	14842.	32724.	17882.	1012.	6002.	12448.	11309.	7097.	3354.	5952.	6986.	3066.	4943.
1993	16197.	37336.	21139.	998.	0.	11069.	9929.	4682.	412.	4567.	6422.	370.	3678.
1994	17690.	42607.	24916.	982.	0.	12949.	11810.	4297.	350.	4610.	5911.	308.	3707.
1995	19338.	48632.	29294.	965.	0.	15130.	13990.	3939.	296.	4647.	5448.	257.	3722.
1996	21157.	55521.	34364.	948.	0.	17655.	16516.	3607.	251.	4679.	5027.	213.	3724.
1997	23165.	63397.	40232.	925.	0.	20578.	19439.	3297.	211.	4705.	4644.	177.	3714.
1998	25384.	72402.	47019.	901.	0.	23960.	22821.	3008.	178.	4727.	4295.	146.	3695.
1999	27836.	82701.	54865.	879.	0.	27870.	26731.	4738.	149.	4744.	3976.	120.	3668.
2000	30547.	94478.	63931.	846.	0.	32388.	31249.	4486.	124.	4757.	3685.	98.	3634.
2001	33546.	107947.	74401.	814.	0.	37607.	36468.	4251.	103.	4765.	3418.	80.	3594.
2002	36865.	123352.	86487.	778.	0.	43633.	42493.	4031.	85.	4770.	3174.	65.	3549.
2003	40539.	140973.	100434.	738.	0.	50586.	49447.	3824.	70.	4772.	2950.	52.	3500.
*	*	*	*	*	*	*	*	*	*	*	*	*	*
*	*	*	*	*	*	*	*	*	*	*	*	*	*
*	*	*	*	*	*	*	*	*	*	*	*	*	*
2012	97911.	470830.	372919.	113.	0.	186516.	185377.	2448.	3.	4663.	1581.	2.	2958.
TOTAL	967835.	3626432.	2658598.	18888.	28583.	1353034.	1324552.	173470.	24289.	125460.	109805.	22813.	95058.

ANALYSIS USING WEIGHTED COST OF CAPITAL (STARTUP YEAR DOLLARS)

MINIMUM REVENUE REQUIREMENTS	PRESENT VALUE	= $159057.	THOUSAND
	UNIT PRESENT VALUE	= $ 7.26	PER MILLION BTU
	LEVELIZED COST ***	= $ 10641.	THOUSAND
	UNIT LEVELIZED COST	= $ 19.00	PER MILLION BTU
	SAVINGS/INVESTMENT RATIO	= 4.19	
	SIMPLE PAYBACK PERIOD	= 3.4	YEARS
	DISCOUNTED PAYBACK PERIOD	= 4.8	YEARS

ANALYSIS USING RETURN ON EQUITY (STARTUP YEAR DOLLARS)

MINIMUM REVENUE REQUIREMENTS	PRESENT VALUE	= $133907.	THOUSAND
	UNIT PRESENT VALUE	= $ 6.11	PER MILLION BTU
	LEVELIZED COST ****	= $ 16274.	THOUSAND
	UNIT LEVELIZED COST	= $ 18.58	PER MILLION BTU
	SAVINGS/INVESTMENT RATIO	= 4.67	
	SIMPLE PAYBACK PERIOD	= 2.8	YEARS
	DISCOUNTED PAYBACK PERIOD	= 3.9	YEARS

* PRESENT VALUE AT STARTUP USING WEIGHTED COST OF CAPITAL = 15.90 PERCENT PER YEAR
** PRESENT VALUE AT STARTUP USING RETURN ON EQUITY = 18.00 PERCENT PER YEAR
*** LEVELIZED COSTS ARE IN CONSTANT STARTUP DOLLARS. TO CONVERT TO CURRENT DOLLARS MULTIPLY BY 1.559
**** LEVELIZED COSTS ARE IN CONSTANT STARTUP DOLLARS. TO CONVERT TO CURRENT DOLLARS MULTIPLY BY 1.505

COALR V1.0 EXAMPLE CASE 2

PRIVATE VENTURE MINIMUM REVENUE REQUIREMENTS
DISCOUNTING WITH WEIGHTED COST OF CAPITAL

(COSTS IN NOVEMBER 1982 DOLLARS)

	COST (1000 $)	DISCOUNT FACTOR	PRESENT VALUE (1000 $)	UNIT PRESENT VALUE * ($/MILLION BTU)	LEVELIZING FACTOR	LEVELIZED COST ** (1000 $)	UNIT LEVELIZED COST *** ($/MILLION BTU)
CAPITAL							
ANNUAL RETURN TO INVESTORS	2341.	6.1164	14316.	.65	1.0000	2341.	2.67
ANNUAL CORPORATE INCOME TAXES	442.	6.1164	2701.	.12	1.0000	442.	.50
ANNUAL PROPERTY TAXES, INSURANCE	287.	6.1164	1756.	.08	1.0000	287.	.33
TOTAL CAPITAL CHARGES	3069.		18772.	.86		3069.	3.50
OPERATING (1987 - 2012)							
LABOR	1703.	6.1164	10413.	.48	1.0000	1703.	1.94
OPERATING + MAINTENANCE MATERIAL	1162.	6.1164	7109.	.32	1.0000	1162.	1.33
ELECTRICITY	256.	14.6643	3759.	.17	2.3975	615.	.70
GAS	19.	27.8883	544.	.02	4.5596	89.	.10
STEAM	17.	14.6643	252.	.01	2.3975	41.	.05
OIL	23.	20.1042	462.	.02	3.2869	76.	.09
COAL	2762.	12.5810	34745.	1.59	2.0569	5681.	6.48
TOTAL OPERATING			57284.	2.62		9366.	10.69
TOTAL LIFE CYCLE COST			76056.	3.47		12435.	14.20

* UNIT PRESENT VALUE BASED ON 21900. BILLION BTU HEAT TRANSFERRED OVER 25.0 YEARS OF LIFE

** LEVELIZED COST IN CONSTANT DISPLAY DOLLARS. TO CONVERT TO CURRENT DOLLARS MULTIPLY BY 2.086

*** CONSTANT DOLLAR UNIT LEVELIZED COST BASED ON 876.00 BILLION BTU HEAT TRANSFERRED PER YEAR

PRIVATE VENTURE MINIMUM REVENUE REQUIREMENTS
DISCOUNTING WITH RETURN ON EQUITY

(COSTS IN NOVEMBER 1982 DOLLARS)

CAPITAL	EQUITY COST (1000 $)	DISCOUNT FACTOR	PRESENT VALUE (1000 $)	UNIT PRESENT VALUE * ($/MILLION BTU)	LEVELIZING FACTOR	LEVELIZED COST ** (1000 $)	UNIT LEVELIZED COST *** ($/MILLION BTU)
ANNUAL RETURN TO EQUITY HOLDERS	1847.	4.8132	8892.	.41	1.0000	1847.	2.11
ANNUAL DEBT SERVICE	566.	4.8132	2723.	.12	1.0000	566.	.65
ANNUAL CORPORATE INCOME TAXES	341.	4.8132	1643.	.08	1.0000	341.	.39
ANNUAL PROPERTY TAXES, INSURANCE	297.	4.8132	1431.	.07	1.0000	297.	.34
TOTAL CAPITAL CHARGES	3052.		14689.	.67		3052.	3.48
OPERATING (1987 - 2012)							
LABOR	1703.	4.8132	8194.	.37	1.0000	1703.	1.94
OPERATING + MAINTENANCE MATERIAL	1162.	4.8132	5595.	.26	1.0000	1162.	1.33
ELECTRICITY	256.	11.0111	2822.	.13	2.2877	586.	.67
GAS	19.	20.2416	395.	.02	4.2054	82.	.09
STEAM	17.	11.0111	189.	.01	2.2877	39.	.04
OIL	23.	14.8424	341.	.02	3.0837	71.	.08
COAL	2782.	9.5257	26307.	1.20	1.9791	5466.	6.24
TOTAL OPERATING			43844.	2.00		9109.	10.40
TOTAL LIFE CYCLE COST			58532.	2.67		12161.	13.88

* UNIT PRESENT VALUE BASED ON 21900. BILLION BTU HEAT TRANSFERRED OVER 25.0 YEARS OF LIFE

** LEVELIZED COST IN CONSTANT DISPLAY DOLLARS. TO CONVERT TO CURRENT DOLLARS MULTIPLY BY 2.014

*** CONSTANT DOLLAR UNIT LEVELIZED COST BASED ON 876.00 BILLION BTU HEAT TRANSFERRED PER YEAR

COALR V1.0 EXAMPLE CASE 2

SUMMARY:

NAVY FINANCED/NAVY OPERATED VENTURE VS. THIRD PARTY FINANCED/THIRD PARTY OPERATED (ALL PRIVATE) VENTURE

	PRESENT VALUE REFERENCED TO DISPLAY YEAR (11/1982)	PRESENT VALUE REFERENCED TO STARTUP YEAR (11/1987)
NAVY FINANCED/NAVY OPERATED VENTURE:		
PRESENT VALUE	$ 70130. THOUSAND	$151145. THOUSAND
UNIT PRESENT VALUE	$ 3.20 PER MILLION BTU	$ 6.90 PER MILLION BTU
LEVELIZED COST	$ 11859. THOUSAND	$ 15973. THOUSAND
UNIT LEVELIZED COST	$ 13.54 PER MILLION BTU	$ 18.12 PER MILLION BTU
SAVINGS/INVESTMENT RATIO	6.08	
DISCOUNTED PAYBACK PERIOD	4.3 YEARS	
THIRD PARTY FINANCED/THIRD PARTY OPERATED (ALL PRIVATE) VENTURE:		
AFTER-TAX NET CASH FLOW ANALYSIS DISCOUNTING WITH WEIGHTED COST OF CAPITAL		
PRESENT VALUE OF MINIMUM REVENUE REQUIREMENT	$ 76056. THOUSAND	$159957. THOUSAND
UNIT PRESENT VALUE	$ 3.47 PER MILLION BTU	$ 7.26 PER MILLION BTU
LEVELIZED COST (REAL $)	$ 12435. THOUSAND	$ 16641. THOUSAND
UNIT LEVELIZED COST	$ 14.20 PER MILLION BTU	$ 19.00 PER MILLION BTU
SAVINGS/INVESTMENT RATIO	4.19	
SIMPLE PAYBACK PERIOD	3.4 YEARS	
DISCOUNTED PAYBACK PERIOD	4.8 YEARS	
AFTER-TAX EQUITY CASH FLOW ANALYSIS DISCOUNTING WITH RETURN ON EQUITY		
PRESENT VALUE OF MINIMUM REVENUE REQUIREMENT	$ 58532. THOUSAND	$133907. THOUSAND
UNIT PRESENT VALUE	$ 2.67 PER MILLION BTU	$ 6.11 PER MILLION BTU
LEVELIZED COST (REAL $)	$ 12161. THOUSAND	$ 16274. THOUSAND
UNIT LEVELIZED COST	$ 13.88 PER MILLION BTU	$ 19.58 PER MILLION BTU
SAVINGS/INVESTMENT RATIO	4.67	
SIMPLE PAYBACK PERIOD	2.8 YEARS	
DISCOUNTED PAYBACK PERIOD	3.9 YEARS	

Table A-3

CASE 3 - THIRD PARTY FINANCED/NAVY OPERATED VENTURE,
SOYD DEPRECIATION, COMPARISON WITH BURNING OIL

INPUT DATA LISTING

```
*    EXAMPLE CASE 3
*
PLANT DATA
PEAK LOAD 200.   LOAD FACTOR .50
*
COAL DATA
PRICE 53.80   DIR 5.
*
UTILITY DATA
OIL 1.0876   DIR 8.
GAS 4.62   DIR 10.
ELECTRIC .06042   DIR 6.
STEAM 10.3   DIR 6.
MANHOURS 30.
*
ECONOMIC DATA
STARTUP YEAR 1987  MONTH 11
DISPLAY YEAR 1982  MONTH 11
COST INDEX 315.0
SCHEDULE 63.0 37.0
LIFE 25.  SALVAGE 0.   DISCOUNT 10.
*
REFORMULATION DATA
CONSTRUCTION 14950   INDEX 216.8
STARTUP 1640   INDEX 216.8
COAL 1540   RATE 30. * $/T
ELECTRIC 140   RATE .033 * $/KWH
GAS 10   RATE  2.37 * $/1000-SCF
OIL 10   RATE .4734 * $/GAL
STEAM 10   RATE 6.00 * $/1000-LB
LABOR 1135   RATE 20. * $/HR
OTHER ANNUAL 800   INDEX 216.8
*
COMPARISON DATA
BURN OIL
*
COMMERCIAL DATA
INFLATION 6.0
DEBT 30   INTEREST 11.   RETURN 18.
THIRD PARTY  LEASE LIFE 15.
INCOME TAX RATE 50. CREDIT 10
PROPERTY TAX PERCENT 2.
DEPRECIATION SOYD LIFE 25
*
END CASE
```

EXAMPLE CASE 3

ECONOMIC DATA

DISPLAY DATE - NOVEMBER 1982

STARTUP DATE - NOVEMBER 1987

SCHEDULE (PERCENT) - 63.00 37.00

DISPLAY YEAR COST INDEX - 315.00

PLANT LIFE (YEARS)	SALVAGE VALUE (1000 REFORMULATION DOLLARS)	NAVY DISCOUNT RATE (PERCENT/YEAR)
25.0	0.	10.00

COMMERCIAL DATA: THIRD PARTY FINANCING

INFLATION RATE:	6.00 PERCENT PER YEAR
DEBT FRACTION:	30.00 PERCENT
INTEREST RATE:	11.00 PERCENT PER YEAR
RETURN ON EQUITY:	18.00 PERCENT PER YEAR
INCOME TAX RATE:	50.00 PERCENT
TAX CREDIT:	10.00 PERCENT
PROPERTY TAX AND INS.:	2.00 PERCENT OF TOTAL CAPITAL REQUIREMENT
SOYD DEPRECIATION LIFE:	25 YEARS
LEASE LIFE:	15 YEARS

CUALR V1.0 EXAMPLE CASE 3

THIRD PARTY FINANCED/NAVY OPERATED VENTURE:
INVESTOR CASH FLOWS DURING CONSTRUCTION PERIOD
(THOUSANDS OF DOLLARS)

YEAR	SOURCE OF FUNDS: DEBT	SOURCE OF FUNDS: EQUITY	USE OF FUNDS: CAPITAL COST	USE OF FUNDS: INTEREST ON DEBT	TOTAL SOURCES AND USES	TAX SAVINGS FROM IDC DEDUCTION	TAX CREDITS	AFTER TAX EQUITY CASH FLOW	PRESENT VALUE: EQUITY** PORTION	PRESENT VALUE: TOTAL* INVESTMENT
1986	3044.	7103.	10147.	0.	10147.	0.	1015.	6088.	7184.	10563.
1987	6551.	15286.	21502.	335.	21837.	167.	1959.	13159.	13159.	19376.
TOTAL	9595.	22388.	31648.	335.	31983.	167.	2974.	19247.	20343.	29938.

* PRESENT VALUE AT STARTUP BASED ON RETURN ON EQUITY = 18.00 PERCENT PER YEAR

** PRESENT VALUE AT STARTUP BASED ON WEIGHTED COST OF CAPITAL = 15.90 PERCENT PER YEAR

CALCULATION OF TAX BASIS
(THOUSANDS OF DOLLARS)

YEAR	PLANT INVESTMENT (INCLUDING STARTUP): DEPRECIABLE PORTION	PLANT INVESTMENT (INCLUDING STARTUP): TOTAL	INTEREST ON DEBT	TAX CREDIT ADJUSTMENT TO TAX BASIS	TAX BASIS
1986	10147.	10147.	0.	0.	10147.
1987	19589.	21502.	335.	0.	19923.
TOTAL	29735.	31648.	335.	0.	30070.

COALR V1.0 EXAMPLE CASE 3

THIRD PARTY FINANCED/NAVY OPERATED VENTURE:
INVESTOR CASH FLOWS DURING OPERATING PERIOD
(THOUSANDS OF DOLLARS)

YEAR	LEVELIZED MINIMUM REVENUE REQUIREMENT	DEBT SERVICE		BEFORE-TAX EQUITY CASH FLOW	DEPREC-IATION	TAXABLE INCOME	TAXES	AFTER-TAX EQUITY CASH FLOW	PRESENT VALUE (PV) AT STARTUP ROE = 18.00 PCT	
		INTEREST PORTION	TOTAL						FACTOR	AMOUNT
1988	7870.	1055.	1334.	6535.	2313.	4501.	2250.	4285.	.847	3631.
1989	7870.	1025.	1334.	6535.	2221.	4624.	2312.	4223.	.718	3033.
1990	7870.	991.	1334.	6535.	2128.	4751.	2375.	4160.	.609	2532.
1991	7870.	953.	1334.	6535.	2036.	4881.	2441.	4095.	.516	2112.
1992	7870.	911.	1334.	6535.	1943.	5016.	2508.	4027.	.437	1760.
1993	7870.	864.	1334.	6535.	1850.	5155.	2577.	3958.	.370	1466.
1994	7870.	813.	1334.	6535.	1758.	5299.	2649.	3886.	.314	1220.
1995	7870.	755.	1334.	6535.	1665.	5449.	2724.	3811.	.266	1014.
1996	7870.	692.	1334.	6535.	1573.	5605.	2802.	3733.	.225	842.
1997	7870.	621.	1334.	6535.	1480.	5768.	2884.	3651.	.191	698.
1998	7870.	542.	1334.	6535.	1388.	5939.	2970.	3566.	.162	577.
1999	7870.	455.	1334.	6535.	1295.	6119.	3059.	3476.	.137	477.
2000	7870.	359.	1334.	6535.	1203.	6308.	3154.	3381.	.116	393.
2001	7870.	251.	1334.	6535.	1110.	6508.	3254.	3281.	.099	323.
2002	7870.	132.	1334.	6535.	1018.	6720.	3360.	3175.	.084	265.
TOTAL	118043.	10420.	20015.	98028.	24981.	82642.	41321.	56707.		20343.

QUALR V1.0 EXAMPLE CASE 3

THIRD PARTY FINANCED/NAVY OPERATED VENTURE:
NAVY CASH FLOWS DURING OPERATING PERIOD
(THOUSANDS OF DOLLARS)

YEAR	LEASE COST CURRENT DOLLARS	LEASE COST CONSTANT DOLLARS	PV* FACTOR FOR LEASE	PV OF LEASE COST	OPERATING COSTS	OPERATING BENEFITS	SAVINGS (OPER. BENEFITS - COSTS)	PV FACTOR FOR SAVINGS AND OPERATING COSTS	PV OF OPERATING COSTS	PV OF SAVINGS
1988	7870.	5548.	.569	3132.	6921.	13163.	6242.	.592	4099.	3697.
1989	7870.	5234.	.513	2686.	7130.	14150.	7020.	.538	3839.	3780.
1990	7870.	4937.	.467	2303.	7351.	15216.	7866.	.489	3598.	3850.
1991	7870.	4658.	.424	1975.	7582.	16368.	8785.	.445	3374.	3909.
1992	7870.	4394.	.386	1694.	7826.	17610.	9784.	.405	3166.	3958.
1993	7870.	4146.	.350	1453.	8083.	18953.	10870.	.368	2972.	3997.
1994	7870.	3911.	.319	1246.	8353.	20402.	12049.	.334	2792.	4028.
1995	7870.	3690.	.290	1069.	8637.	21967.	13329.	.304	2625.	4051.
1996	7870.	3481.	.263	917.	8937.	23656.	14720.	.276	2469.	4067.
1997	7870.	3284.	.239	786.	9252.	25481.	16229.	.251	2324.	4076.
1998	7870.	3098.	.218	674.	9583.	27451.	17868.	.228	2188.	4080.
1999	7870.	2922.	.198	578.	9933.	29578.	19646.	.208	2062.	4078.
2000	7870.	2757.	.180	496.	10300.	31875.	21575.	.189	1944.	4071.
2001	7870.	2601.	.164	429.	10687.	34356.	23668.	.172	1833.	4060.
2002	7870.	2454.	.149	365.	11095.	37034.	25939.	.156	1730.	4045.
2003	0.	0.	.135	0.	11524.	39926.	28402.	.142	1634.	4027.
2004	0.	0.	.123	0.	11977.	43050.	31073.	.129	1544.	4005.
2005	0.	0.	.112	0.	12453.	46422.	33969.	.117	1459.	3980.
2006	0.	0.	.102	0.	12955.	50063.	37109.	.107	1380.	3953.
2007	0.	0.	.092	0.	13483.	53996.	40512.	.097	1306.	3923.
2008	0.	0.	.084	0.	14040.	58242.	44202.	.088	1236.	3891.
2009	0.	0.	.076	0.	14627.	62827.	48200.	.080	1171.	3858.
2010	0.	0.	.069	0.	15246.	67779.	52533.	.073	1109.	3822.
2011	0.	0.	.063	0.	15897.	73125.	57228.	.066	1051.	3785.
2012	0.	0.	.057	0.	16584.	78899.	62315.	.060	997.	3747.
TOTAL	118043.	57113.		19799.	270457.	921590.	651133.		53903.	98739.

PRESENT VALUE OF COSTS	= $ 73702. THOUSAND		(LEASE PLUS OPERATING COSTS)
UNIT PRESENT VALUE	= $ 3.37 PER MILLION BTU		(PV / 21900. BILLION BTU)
LEVELIZED COST	= $ 12463. THOUSAND		(PV * .1691
UNIT LEVELIZED COST	= $ 14.23 PER MILLION BTU		(LEVELIZED COST / 876. BILLION BTU)
SAVINGS/INVESTMENT RATIO	= 4.99		(PV SAVINGS / PV LEASE)
DISCOUNTED PAYBACK PERIOD	= 9.2 YEARS		(NO. OF YEARS NEEDED FOR CUMULATIVE PV SAVINGS = TOTAL PV LEASE)

* PV DENOTES PRESENT VALUE.
** PRESENT VALUES ARE REFERENCED TO THE DISPLAY YEAR.
*** LEVELIZED COSTS ARE IN CONSTANT DISPLAY YEAR DOLLARS.

COALK V1.0 EXAMPLE CASE 3

SUMMARY:

NAVY FINANCED/NAVY OPERATED VENTURE VS. THIRD PARTY FINANCED/NAVY OPERATED VENTURE

	PRESENT VALUE REFERENCED TO DISPLAY YEAR (11/1982)	PRESENT VALUE REFERENCED TO STARTUP YEAR (11/1987)
NAVY FINANCED/NAVY OPERATED VENTURE:		
PRESENT VALUE	$ 70130. THOUSAND	$151145. THOUSAND
UNIT PRESENT VALUE	$ 3.20 PER MILLION BTU	$ 6.90 PER MILLION BTU
LEVELIZED COST	$ 11859. THOUSAND	$ 15979. THOUSAND
UNIT LEVELIZED COST	$ 13.54 PER MILLION BTU	$ 18.12 PER MILLION BTU
SAVINGS/INVESTMENT RATIO	6.08	
DISCOUNTED PAYBACK PERIOD	4.3 YEARS	
THIRD PARTY FINANCED/NAVY OPERATED VENTURE:		
NAVY OPERATOR		
PRESENT VALUE	$ 73702. THOUSAND	$158944. THOUSAND
UNIT PRESENT VALUE	$ 3.37 PER MILLION BTU	$ 7.29 PER MILLION BTU
LEVELIZED COST	$ 12463. THOUSAND	$ 16679. THOUSAND
UNIT LEVELIZED COST	$ 14.23 PER MILLION BTU	$ 19.04 PER MILLION BTU
SAVINGS/INVESTMENT RATIO	4.99	
DISCOUNTED PAYBACK PERIOD	5.2 YEARS	
PRIVATE INVESTOR		
LEVELIZED REVENUE (LEASE)	$ 7870. THOUSAND PER YEAR	
LEASE LIFE	15 YEARS	

Table A-4

CASE 4 - THIRD PARTY FINANCED/NAVY OPERATED VENTURE,
ACRS DEPRECIATION, COMPARISON WITH WITH BURNING GAS

INPUT DATA LISTING

```
*    EXAMPLE CASE 4
*
PLANT DATA
PEAK LOAD 200.   LOAD FACTOR .50
*
COAL DATA
PRICE 53.80   DIR 5.
*
UTILITY DATA
OIL 1.0876   DIR 8.
GAS 4.62   DIR 10.
ELECTRIC .06042   DIR 6.
STEAM 10.3   DIR 6.
MANHOURS 30.
*
ECONOMIC DATA
STARTUP YEAR 1987  MONTH 11
DISPLAY YEAR 1982  MONTH 11
COST INDEX 315.0
SCHEDULE 63.0 37.0
LIFE 25.  SALVAGE 0.   DISCOUNT 10.
*
REFORMULATION DATA
CONSTRUCTION 14950   INDEX 216.8
STARTUP 1640   INDEX 216.8
COAL 1540   RATE 30. * $/T
ELECTRIC 140   RATE .033 * $/KWH
GAS 10   RATE  2.37 * $/1000-SCF
OIL 10   RATE .4734 * $/GAL
STEAM 10   RATE 6.00 * $/1000-LB
LABOR 1135   RATE 20. * $/HR
OTHER ANNUAL 800   INDEX 216.8
*
COMPARISON DATA
BURN GAS
*
COMMERCIAL DATA
INFLATION 6.0
DEBT 30   INTEREST 11.   RETURN 16.
THIRD PARTY  LEASE LIFE 15.
INCOME TAX RATE 50. CREDIT 10
PROPERTY TAX PERCENT 2.
DEPRECIATION ACRS LIFE 5
*
END JOB
```

ECONOMIC DATA

DISPLAY DATE - NOVEMBER 1982

STARTUP DATE - NOVEMBER 1987

SCHEDULE (PERCENT) - 63.00 37.00

DISPLAY YEAR COST INDEX - 315.00

PLANT LIFE (YEARS)	SALVAGE VALUE (1000 REFORMULATION DOLLARS)	NAVY DISCOUNT RATE (PERCENT/YEAR)
25.0	0.	10.00

COMMERCIAL DATA: THIRD PARTY FINANCING

INFLATION RATE:	6.00	PERCENT PER YEAR
DEBT FRACTION:	30.00	PERCENT
INTEREST RATE:	11.00	PERCENT PER YEAR
RETURN ON EQUITY:	18.00	PERCENT PER YEAR
INCOME TAX RATE:	50.00	PERCENT
TAX CREDIT:	10.00	PERCENT
PROPERTY TAX AND INS.:	2.00	PERCENT OF TOTAL CAPITAL REQUIREMENT
ACRS DEPRECIATION LIFE:	5	YEARS
LEASE LIFE:	15	YEARS

COALR V1.0 EXAMPLE CASE 4

NAVY COST AND BENEFIT ANALYSIS
(THOUSANDS OF DISPLAY YEAR DOLLARS)

YEAR	CONSTRUCT COSTS	STARTUP COST	OPERATING COSTS	OPERATING BENEFITS	SAVINGS (OPERATING BENEFITS -COSTS)	PRESENT VALUE DISCOUNT FACTOR	PV* OF CONSTRUCT + STARTUP COSTS	PV OF OPERATING COSTS	PV OF SAVINGS
1986	8037.					.717	5759.		
1987	13685.	2383.				.651	10468.		
1988			6421.	9506.	2585.	.592		4099.	1531.
1989			7130.	10371.	3241.	.538		3834.	1745.
1990			7351.	11323.	3972.	.489		3598.	1944.
1991			7582.	12369.	4787.	.445		3374.	2130.
1992			7826.	13520.	5694.	.405		3166.	2303.
1993			8083.	14785.	6702.	.368		2972.	2465.
1994			8353.	16176.	7823.	.334		2792.	2615.
1995			8637.	17705.	9068.	.304		2625.	2756.
1996			8937.	19387.	10450.	.276		2469.	2887.
1997			9252.	21236.	11984.	.251		2324.	3010.
1998			9583.	23269.	13686.	.228		2188.	3125.
1999			9933.	25505.	15573.	.208		2062.	3233.
2000			10300.	27964.	17664.	.189		1944.	3333.
2001			10687.	30667.	19980.	.172		1833.	3428.
2002			11095.	33641.	22546.	.156		1730.	3516.
2003			11524.	36910.	25386.	.142		1634.	3599.
2004			11977.	40505.	28529.	.129		1544.	3677.
2005			12453.	44459.	32006.	.117		1459.	3750.
2006			12955.	48807.	35853.	.107		1380.	3819.
2007			13483.	53589.	40106.	.097		1306.	3884.
2008			14040.	58848.	44807.	.088		1236.	3945.
2009			14627.	64631.	50003.	.080		1171.	4002.
2010			15246.	70990.	55745.	.073		1109.	4056.
2011			15897.	77985.	62087.	.066		1051.	4107.
2012			16584.	85677.	69093.	.060		997.	4154.
TOTAL	21722.	2383.	270457.	869829.	599368.		16227.	53903.	79013.

PRESENT VALUE OF COSTS = $ 70130. THOUSAND
UNIT PRESENT VALUE = $ 3.20 PER MILLION BTU (PV / 21900. BILLION BTU)
LEVELIZED COST = $ 11859. THOUSAND (PV * .1691)
UNIT LEVELIZED COST = $ 13.54 PER MILLION BTU (LEVELIZED COST / 876. BILLION BTU)
SAVINGS/INVESTMENT RATIO = 4.87 (PV SAVINGS / PV INVESTMENT)
DISCOUNTED PAYBACK PERIOD = 7.5 YEARS (NO. OF YEARS NEEDED FOR CUMULATIVE PV SAVINGS = PV INVESTMENT)

* PV DENOTES PRESENT VALUE

COALR V1.0 EXAMPLE CASE 4

THIRD PARTY FINANCED/NAVY OPERATED VENTURE:
NAVY CASH FLOWS DURING OPERATING PERIOD
(THOUSANDS OF DOLLARS)

YEAR	LEASE COST CURRENT DOLLARS	LEASE COST CONSTANT DOLLARS	PV* FACTOR FOR LEASE	PV OF LEASE COST	OPERATING COSTS	OPERATING BENEFITS	SAVINGS (OPER. BENEFITS - COSTS)	PV FACTOR FOR SAVINGS AND OPERATING COSTS	PV OF OPERATING COSTS	PV OF SAVINGS
1988	6354.	4479.	.564	2528.	6921.	9506.	2585.	.592	4099.	1531.
1989	6354.	4225.	.513	2168.	7130.	10371.	3241.	.538	3839.	1745.
1990	6354.	3986.	.467	1860.	7351.	11323.	3972.	.489	3598.	1944.
1991	6354.	3761.	.424	1595.	7582.	12369.	4787.	.445	3374.	2130.
1992	6354.	3548.	.386	1368.	7826.	13520.	5694.	.405	3166.	2303.
1993	6354.	3347.	.350	1173.	8083.	14785.	6702.	.368	2972.	2465.
1994	6354.	3158.	.319	1006.	8353.	16176.	7823.	.334	2792.	2615.
1995	6354.	2979.	.290	863.	8637.	17705.	9068.	.304	2625.	2756.
1996	6354.	2810.	.263	740.	8937.	19387.	10450.	.276	2469.	2887.
1997	6354.	2651.	.239	635.	9252.	21236.	11984.	.251	2324.	3010.
1998	6354.	2501.	.218	544.	9583.	23269.	13686.	.228	2188.	3125.
1999	6354.	2359.	.198	467.	9933.	25505.	15573.	.208	2062.	3233.
2000	6354.	2226.	.180	400.	10300.	27964.	17664.	.189	1944.	3333.
2001	6354.	2100.	.164	343.	10687.	30667.	19980.	.172	1833.	3428.
2002	6354.	1981.	.149	294.	11095.	33641.	22546.	.156	1730.	3516.
2003	0.	0.	.135	0.	11524.	36910.	25386.	.142	1634.	3599.
2004	0.	0.	.123	0.	11977.	40505.	28529.	.129	1544.	3677.
2005	0.	0.	.112	0.	12453.	44459.	32006.	.117	1459.	3750.
2006	0.	0.	.102	0.	12955.	48807.	35853.	.107	1380.	3819.
2007	0.	0.	.092	0.	13483.	53589.	40106.	.097	1306.	3884.
2008	0.	0.	.084	0.	14040.	58848.	44807.	.088	1236.	3945.
2009	0.	0.	.076	0.	14627.	64631.	50003.	.080	1171.	4002.
2010	0.	0.	.069	0.	15246.	70990.	55745.	.073	1109.	4056.
2011	0.	0.	.063	0.	15897.	77985.	62097.	.066	1051.	4107.
2012	0.	0.	.057	0.	16584.	85677.	69093.	.060	997.	4154.
TOTAL	95303.	46111.		15965.	270457.	869825.	599368.		53903.	79013.

PRESENT VALUE OF COSTS = $ 69868. THOUSAND (LEASE PLUS OPERATING COSTS)
UNIT PRESENT VALUE = $ 3.19 PER MILLION BTU (PV / 21900. BILLION BTU)
LEVELIZED COST = $ 11818. THOUSAND (PV * .1691
UNIT LEVELIZED COST = $ 13.49 PER MILLION BTU (LEVELIZED COST / 876. BILLION BTU)
SAVINGS/INVESTMENT RATIO = 4.94 (PV SAVINGS / PV LEASE)
DISCOUNTED PAYBACK PERIOD = 7.5 YEARS (NO. OF YEARS NEEDED FOR CUMULATIVE PV SAVINGS = TOTAL PV LEASE)

* PV DENOTES PRESENT VALUE.
** PRESENT VALUES ARE REFERENCED TO THE DISPLAY YEAR.
*** LEVELIZED COSTS ARE IN CONSTANT DISPLAY YEAR DOLLARS.

COALR V1.0 EXAMPLR CASE 4

SUMMARY:

NAVY FINANCED/NAVY UPERATED VENTURE VS. THIRD PARTY FINANCED/NAVY UPERATED VENTURE

	PRESENT VALUE REFERENCED TU DISPLAY YEAR (11/1982)	PRESENT VALUE REFERENCED TU STARTUP YEAR (11/1987)
NAVY FINANCED/NAVY UPERATED VENTURE:		
PRESENT VALUE	$ 70130. THOUSAND	$151145. THOUSAND
UNIT PRESENT VALUE	$ 3.20 PER MILLION BTU	$ 5.90 PER MILLION BTU
LEVELIZED COST	$ 11859. THOUSAND	$ 15870. THOUSAND
UNIT LEVELIZED COST	$ 13.94 PER MILLION BTU	$ 18.12 PER MILLION BTU
SAVINGS/INVESTMENT RATIO	4.87	
DISCOUNTED PAYBACK PERIOD	7.5 YEARS	
THIRD PARTY FINANCED/NAVY UPERATED VENTURE:		
NAVY OPERATOR		
PRESENT VALUE	$ 69888. THOUSAND	$150624. THOUSAND
UNIT PRESENT VALUE	$ 3.19 PER MILLION BTU	$ 5.98 PER MILLION BTU
LEVELIZED COST	$ 11818. THOUSAND	$ 15916. THOUSAND
UNIT LEVELIZED COST	$ 13.49 PER MILLION BTU	$ 18.05 PER MILLION BTU
SAVINGS/INVESTMENT RATIO	4.99	
DISCOUNTED PAYBACK PERIOD	7.5 YEARS	
PRIVATE INVESTOR		
LEVELIZED REVENUE (LEASE)	$ 6354. THOUSAND PER YEAR	
LEASE LIFE	15 YEARS	

Appendix B

PROCEDURE TO CONVERGE TO A DESIRED OUTPUT QUANTITY BY A METHOD OF SUCCESSIVE TRIALS

One purpose of COALR is to permit determination of input assumptions that are consistent with calculated quantities published in reports or included in proposals to the Navy. Since the calculations in COALR proceed from input to calculated quantities, and are not reversible, it is necessary to find the correct values of input variables by a search procedure of some kind. This appendix presents a search procedure that is rapidly converging and easy to use. The procedure is a method of successive trials.

The method of successive trials can be carried out for either of the following two choices for the input variables sought:

- Scalar procedure: only a single input variable is to be adjusted by the trial procedure.
- Vector procedure: two or more input variables are to be adjusted at the same time by the trial procedure.

In the scalar procedure, the method of successive trials consists of the following steps:

1. Select the input variable whose value will be sought by the trial procedure. Denote this variable by x.
2. Define a trial index i, and initialize it to i = 1.
3. Prepare the input for a first trial case, which includes a first trial value, x_i, for variable x. The first value x_i is arbitrary.
4. Make a run for the trial case with input containing x_i, and record the resulting value y_i of the calculated quantity.

5. Select an amount Δx by which variable x will be changed in the next trial. The Δx selected is arbitrary.

6. Prepare an input for a next trial case in which x has the value $x_{i+1} = x_i + \Delta x$.

7. Make a run for the trial case with input containing x_{i+1}, and record the resulting value y_{i+1} of the calculated quantity.

8. Decide whether y_{i+1} is sufficiently close to the desired value y^0 of the calculated quantity. If it is, terminate the procedure.

9. If y_{i+1} is not sufficiently close to y^0; calculate a next change in x given by

$$\Delta x = -(y_{i+1} - y^0)/s$$

where s is the slope

$$s = (y_{i+1} - y_i)/(x_{i+1} - x_i)$$

10. Increase the trial index i by one and return to Step 6.

The scalar extrapolation process is described pictorially in Figure B-1. The procedure above is simply one of linear interpolation or extrapolation.

In the vector procedure, the method of successive trials consists of the following steps:

1. Select the set of n input variables whose values will be sought by the trial procedure. Denote these variables by $a^1, a^2, \ldots, a^n$, and consider them components of a vector A in an n-dimensional vector space.

2. Define a trial index i, and initialize it to i = 1.

3. Prepare the input for a first trial case which includes first trial values a_i^j of the components of vector A. These trial components make up first trial vector A_i.

4. Make a run for the trial case, and record the value y_i of the calculated quantity.

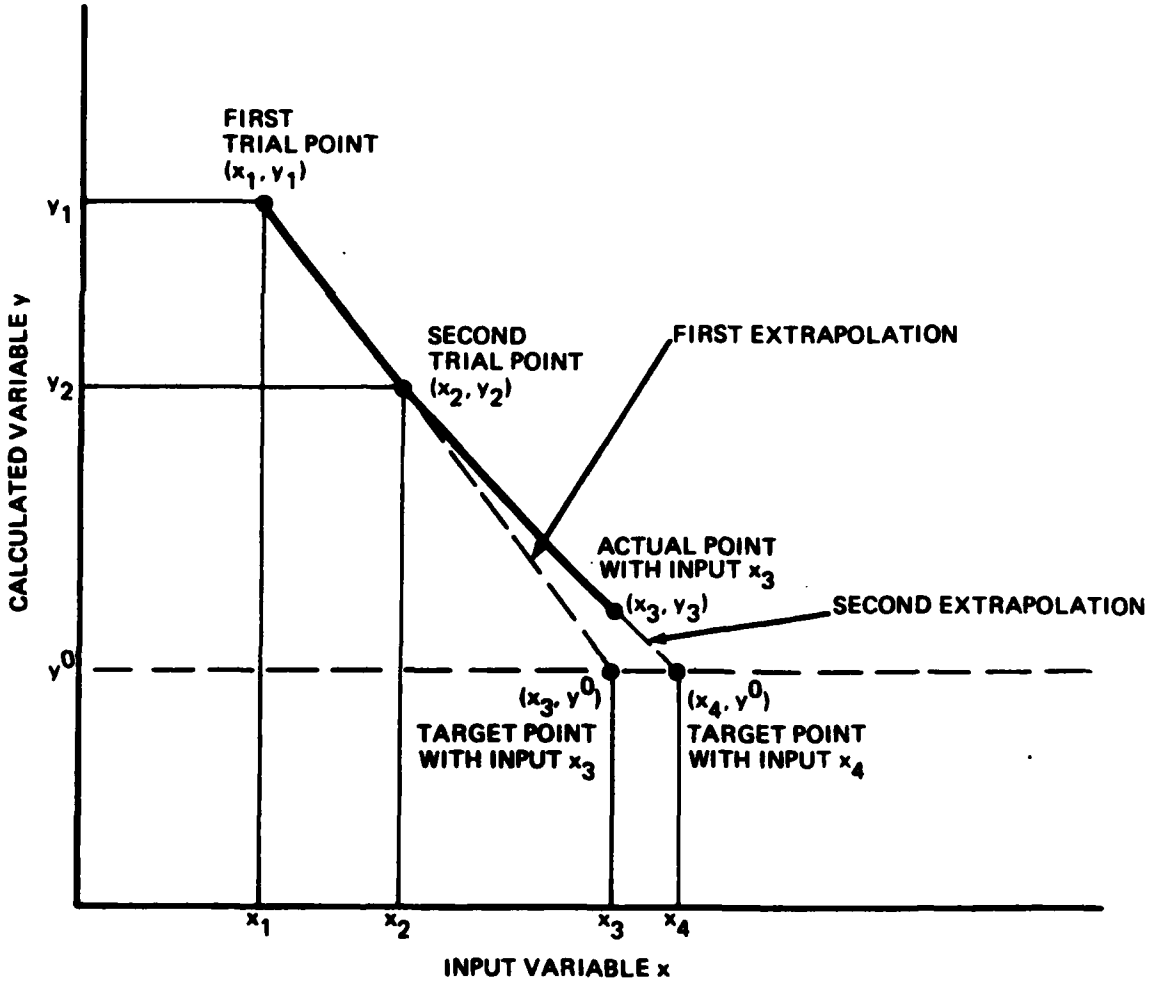


Figure B-1 METHOD OF SUCCESSIVE TRIALS FOR A SCALAR INPUT VARIABLE

5. Select a change vector B with components $b^1, b^2, \ldots, b^n$. This vector defines the direction of the changes in A by the trial procedure. It may be convenient to select b^1 equal to one, so that b^2, ..., b^n define the ratio of the changes in variables $a^2, \ldots, a^n$ to the change in variable a^1.

6. Introduce a trial parameter x, which defines the changed value of vector A through the equation

$$A = A_0 + xB$$

where A_0 is any initial choice of vector A.

7. Select an amount Δx by which variable x will be changed in the next trial. The Δx selected is arbitrary.

8. Enter Step 6 of the scalar procedure.

The vector extrapolation process is described pictorially in Figure B-2.

Table B-1 indicates which input variables will increase a calculated quantity and which will decrease it. This information is useful in selecting the first two trial cases to start the procedure. If the vector procedure is selected, it is generally desirable to choose a change vector in which either all the components increase the calculated quantity or all the components decrease the calculated quantity. Otherwise, the effects of changes in components may have opposing effects which cancel.

Figure B-3 is a calculation form that will guide the reader through the procedure. Table B-2 presents a sample calculation utilizing the scalar procedure. Table B-3 presents a sample calculation utilizing the vector procedure.

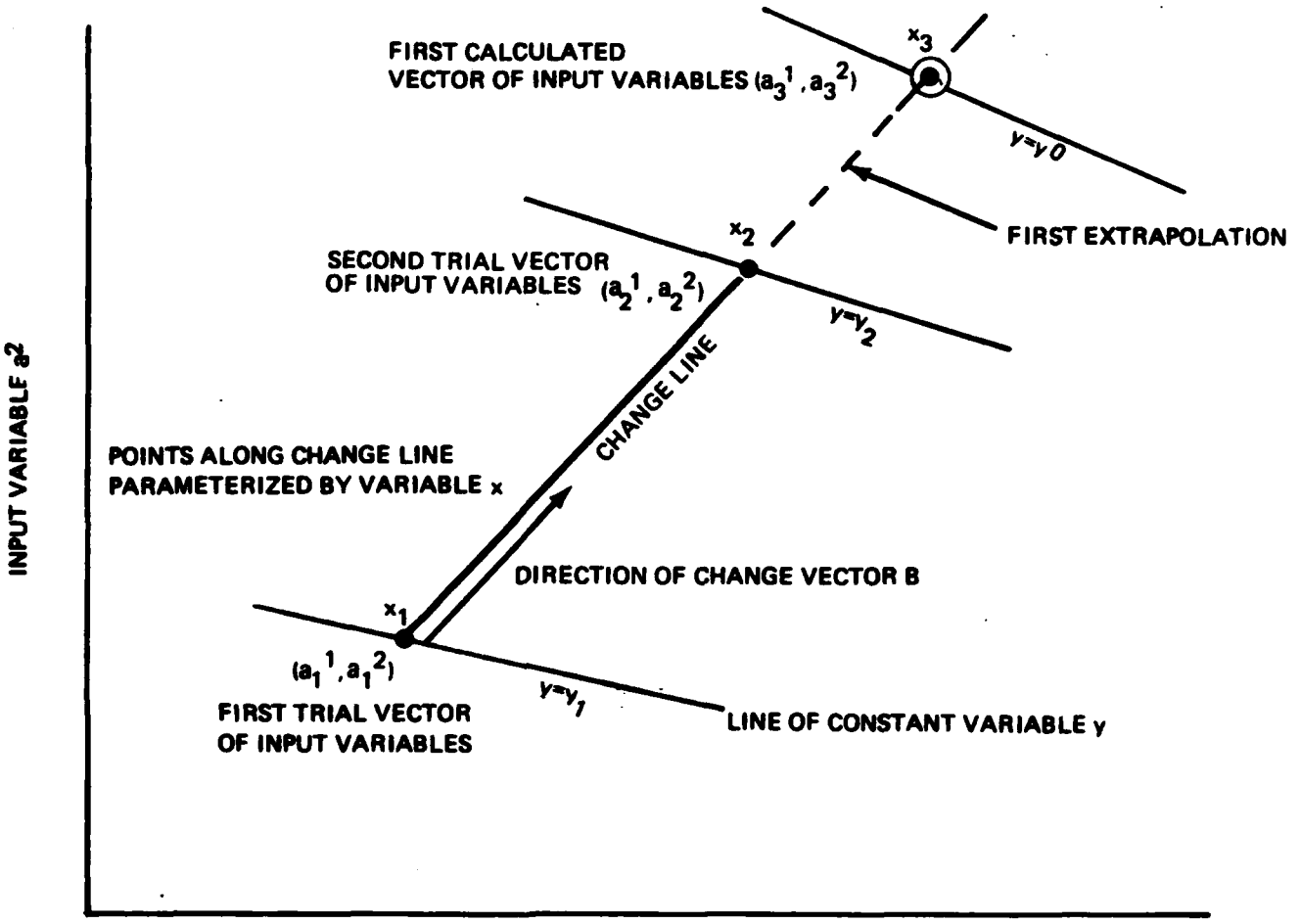


Figure B-2 METHOD OF SUCCESSIVE TRIALS FOR A 2-COMPONENT VECTOR OF INPUT VARIABLES

Table B-1

DIRECTION OF CHANGE IN CALCULATED QUANTITIES
PRODUCED BY INCREASES IN INPUT VARIABLES

Input Variable Increased	Unit Levelized Cost (constant $)	Savings/ Investment Ratio	Payback Period
Reformulation Year Construction Cost	+(1)	-(2)	+
Reformulation Year Startup Cost	+	-	+
Reformulation Year Annual Coal Cost	+	-	+
Reformulation Year Annual Electricity Cost	+	-	+
Reformulation Year Annual Gas Cost	+	-	+
Reformulation Year Annual Oil Cost	+	-	+
Reformulation Year Annual Auxiliary Steam Cost	+	-	+
Reformulation Year Annual Labor Cost	+	-	+
Reformulation Year Other Annual Costs	+	-	+
Reformulation Year Cost Index	-	+	-
Reformulation Year Coal Rate	-	+	-
Reformulation Year Electricity Rate	-	+	-
Reformulation Year Gas Rate	-	+	-
Reformulation Year Oil Rate	-	+	-
Reformulation Year Auxiliary Steam Rate	-	+	-
Reformulation Year Labor Rate	-	+	-
Display Year Coal Price	+	-	+
Display Year Electricity Price	+	-	+
Display Year Auxiliary Oil Rate	+	-	+
Display Year Auxiliary Gas Rate	+	-	+
Display Year Auxiliary Steam Rate	+	-	+
Display Year Labor Rate	+	-	+
Display Year Coal DIR(3)	+	-	+

(1) + = calculated quantity increases.
(2) - = calculated quantity decreases.
(3) DIR = differential inflation rate.
(4) N/A = not applicable.
(5) ? = calculated quantity could increase or decrease.

Table B-1 (Cont'd)

Input Variable Increased	Unit Levelized Cost (constant $)	Savings/ Investment Ratio	Payback Period
Display Year Electricity DIR	+	-	+
Display Year Auxiliary Oil DIR	+	-	+
Display Year Auxiliary Gas DIR	+	-	+
Display Year Auxiliary Steam DIR	+	-	+
Display Year Alternative Oil Rate	N/A(4)	+	-
Display Year Alternative Gas Rate	N/A	+	-
Display Year Alternative Oil DIR	N/A	+	-
Display Year Alternative Gas DIR	N/A	+	-
Display Year Cost Index	+	-	+
Peak Load	-	?(5)	?
Load Factor	-	?	?
Plant Life	-	?	?
Salvage Value	-	+	-
Navy Constant Dollar Discount Rate	+	-	+
Number of Construction Years	+	-	+
Years from Display to Startup Years	?	?	?
Inflation Rate	-	+	-
Fraction of Investment that is Debt	-	+	-
Rate of Interest on Debt	+	-	+
Rate of Return on Equity	+	-	+
Duration of Third Party Lease	?	?	?
Income Tax Rate	+	-	+
Income Tax Credit	+	-	+
Property Tax Percent	+	-	+
Depreciation Life	+	-	+

(1) + = calculated quantity increases.
(2) - = calculated quantity decreases.
(3) DIR = differential inflation rate.
(4) N/A = not applicable.
(5) ? = calculated quantity could increase or decrease.

Figure B-3

FORM FOR PREPARING SUCCESSIVE TRIALS COMPUTATION OF INDEPENDENT VARIABLE X TO GIVE TARGET DEPENDENT VARIABLE Y

Title of Computation _____

Name of Independent Variable x _____

Name of Dependent Variable y _____

Target Value of y _____

Tabulation of Results of Succesive Trials

Trial Number i	1	2	3	4
Trial Input x_i: Units: ____				
Calculated y_i: Units: ____				
Target Value of y^0				
Error in y = $\Delta y_i^0 = (y_i - y^0)$				

Computation of Next Trial Value of x

Correction Number j	1	2	3
Change in y Between Trials, Δy_j			
Change in x Between Trials, Δx_j			
Slope, $\Delta y_j/\Delta x_j$			
Next Change in y Should Equal Minus the Error in y: $\Delta y = -\Delta y_i^0$			
Next Change in Input x: $\Delta x = \Delta y/(\Delta y_j/\Delta x_j)$			
Next Input: $x_{i+1} = x_i + \Delta x$			

Table B-2

SCALAR PROCEDURE SAMPLE PROBLEM

Background

A third party approaches the Navy offering to finance the coal-use plant in the example in Table A-1. The third party will compute its annual lease charge to the Navy using the financial assumptions of that example.

Problem: Determine the Navy discount rate equivalent to the financing costs of the third party.

Approach: Find the Navy discount rate that gives identical values for the following:

- The present value of the total capital requirement in a Navy financed/Navy operated venture (from Report 3)
- The cumulative present value of lease payments in a third party financed/Navy operated venture (from Report 8)

Method: Calculate the ratio of the total capital present value to the cumulative lease present value. Find by successive trials the discount rate that makes the ratio equal to 1.0.

Starting Data

Trial Number i	1	2	3	4
Trial Input x: Units: %/yr	10	9	9.733	_____
Calculated y: Units: Dimensionless	1.015	0.958	0.9998	_____

Calculation of y

Calculated Navy Present Values from Output:				
PV of Investment: Units: $1000	16227	16852	16391	
PV of Lease: Units: $1000	15985	17582	16393	
Calculated y = Ratio (Dimensionless)	1.015	0.958	0.9998	

Table B-2 (Cont'd)

Computation Form Calculations

Title of Computation	Sample Scalar Problem
Name of Independent Variable x	Navy Discount Rate
Name of Dependent Variable y	Ratio of PV's: Investment/Lease
Target Value of y	1.0

Tabulation of Results of Successive Trials

Trial Number i	1	2	3	4
Trial Input x_i: Units: %/yr	10	9	9.733	
Calculated y_i: Units: Dimensionless	1.0151	0.9585	0.9998	
Target Value of y^0	1.0000	1.0000	1.0000	
Error in y = $\Delta y_i^0 = (y_i - y^0)$	0.0151	-0.0415	-0.0002	

Computation of Next Trial Value of x

Correction Number j	1	2	3
Change in y Between Trials, Δy_j	-0.0566		
Change in x Between Trials, Δx_j	-1		
Slope, $\Delta y_j/\Delta x_j$	0.0566		
Next Change in y Should Equal Minus the Error in y: $\Delta y = -\Delta y_i^0$	0.0415		
Next Change in Input x: $\Delta x = \Delta y/(\Delta y_j/\Delta x_j)$	0.7333		
Next Input: $x_{i+1} = x_i + \Delta x$	9.7333		

Table B-3

VECTOR PROCEDURE SAMPLE PROBLEM

Background

The Navy seeks a third party to finance the coal-use plant in the example in Table A-1. The Navy is prepared to pay commercial financing costs if they have an equivalent Navy discount rate no higher than 10 percent.

Problem: Determine how much higher the example interest and return rates may be raised to give an equivalent Navy discount rate of 10 percent.

Approach: Find the amount to be added to both the return rate and the interest rate that gives identical values of the following:

- The present value of the total capital requirement in a Navy financed/Navy operated venture when the Navy discount rate is 10 percent (from Report 3)
- The cumulative present value of the lease payments in a third party financed/Navy operated venture, when calculated with a Navy discount rate of 10 percent (from Report 8)

Method: Calculate the ratio of the total capital present value to the cumulative lease present value. Find by successive trials the amount added to both interest and return rates to make the ratio equal to 1.0. Use as x the weighted cost of capital formed from the interest and return rates.

Starting Data

Trial Number i	1	2	3	4
Trial Input x: Units: %/yr	15.9	16.9	16.174	_____
Calculated y: Units: Dimensionless	1.015	0.9559	0.9996	_____
Calculation of Input x				
Interest Units: %/yr	18	19	18.274	_____
Return Units: %/yr	11	12	11.274	_____
x, Weighted Cost of Capital(1)	15.9	16.9	16.174	_____

(1) When a given amount is added to both the interest and the return, the weighted cost of capital also increases by that amount.

Table B-3 (Cont'd)

Calculation of y

Calculated Navy Present Values from Output when Navy Discount Rate is 10%/yr:				
PV of Investment:	Units: $1000	16227	16227	16227
PV of Lease:	Units: $1000	15985	16905	16234
Calculated y = Ratio (Dimensionless)		1.015	0.9599	0.9996

Computation Form Calculations

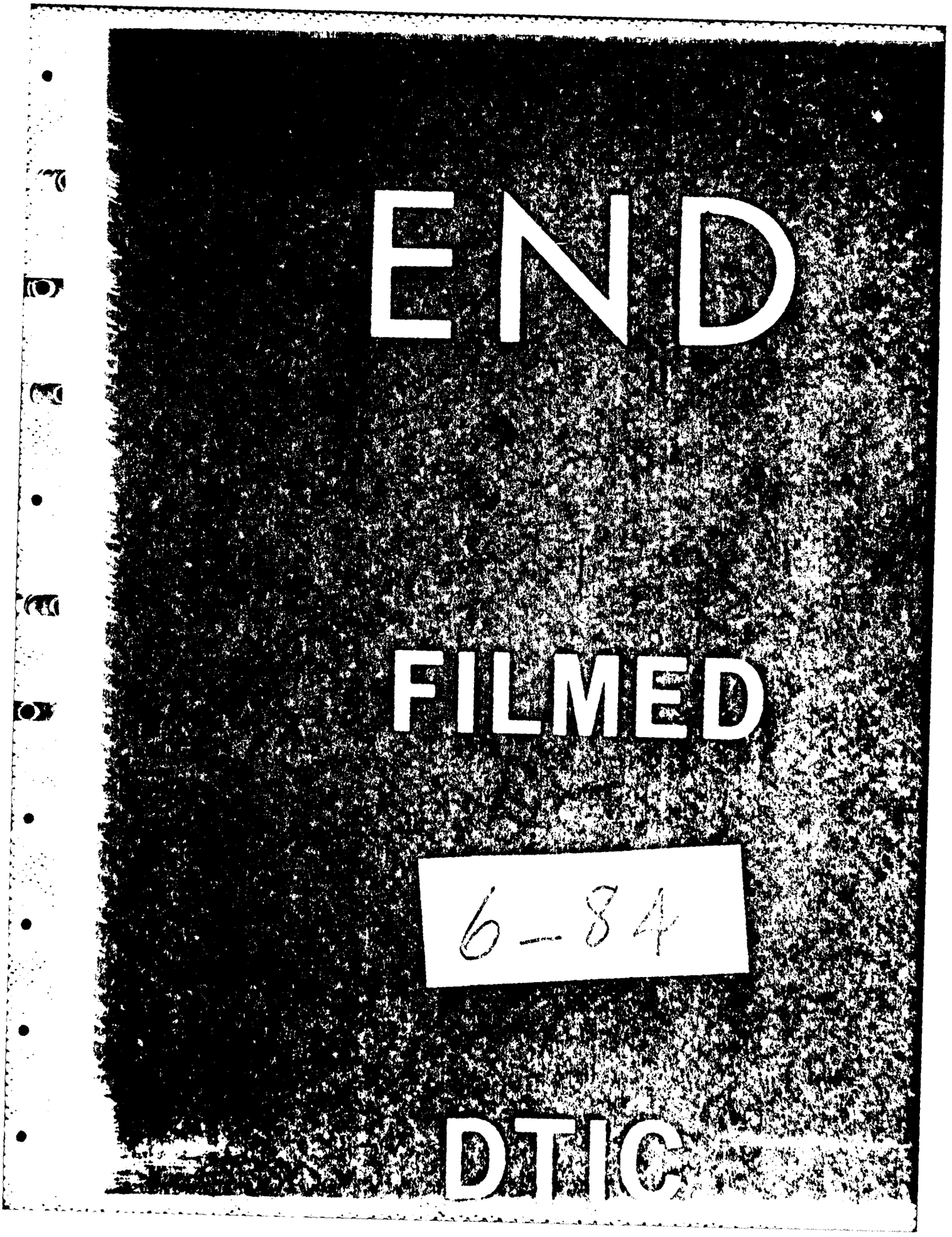
Title of Computation	Sample Vector Problem
Name of Independent Variable x	Weighted Cost of Capital
Name of Dependent Variable y	Ratio of PV's: Investment/Lease
Target Value of y	1.0

Tabulation of Results of Successive Trials

Trial Number i	1	2	3	4
Trial Input x_i: Units: %/yr	15.90	16.90	16.174	_____
Calculated y_i: Units: Dimensionless	1.0151	0.9599	0.9996	_____
Target Value of y^0	1.0000	1.0000	1.0000	_____
Error in y = $\Delta y_i^0 = (y_i - y^0)$	0.0151	-0.0401	-0.0004	_____

Computation of Next Trial Value of x

Correction Number j	1	2	3
Change in y Between Trials, Δy_j	-0.0552	_____	_____
Change in x Between Trials, Δx_j	+1.0	_____	_____
Slope, $\Delta y_j/\Delta x_j$	-0.0552	_____	_____
Next Change in y Should Equal Minus the Error in y: $\Delta y = -\Delta y_i^0$	+0.0401	_____	_____
Next Change in Input x: $x = y/(\Delta y_j/\Delta x_j)$	-0.7262	_____	_____
Next Input: $x_{i+1} = x_i + \Delta x$	16.1738	_____	_____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